Missouri Department of Natural Resources

Biological Assessment Study

North Fork of the Spring River
Barton and Jasper Counties

2012 - 2013

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

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1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), Water Pollution Control Branch (**WPCB**), the Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) conducted a macroinvertebrate bioassessment study of the North Fork of the Spring River (**NFSR**) in Barton and Jasper counties. This was a reassessment of a 55.9 mile segment of the NFSR that was previously sampled in other bioassessment studies (MDNR 2004, 2005a, 2008). This 55.9 mile segment of the NFSR (Water Body Identification {**WBID**} 3188) flows from just upstream of Golden City to the confluence of Dry Fork Creek, which is located southeast of the town of Jasper. Macroinvertebrates and surface water samples were collected at ten stations during the fall 2012 and seven stations during the spring 2013 sampling seasons. Ten stations were scheduled to be sampled during the spring 2013 sampling season, but only seven were sampled because of high water levels. The 55.9 mile segment of stream is currently on the 2012 303(d) list for ammonia, bacteria, and low dissolved oxygen. This section of stream was originally placed on the 2002 303(d) list for sediment.

1.1 Study Area/Justification

NFSR originates in western Dade County between the towns of Lockwood, and Golden City, and is located within the Ozark/Neosho Ecological Drainage Unit (**EDU**). The dominant land use types in the NFSR watershed are cropland and grassland (Figure 1 and Table 1). NFSR is listed in the Missouri Water Quality Standards (**WQS**) (MDNR 2014) as a class “C” stream for its first 55.9 miles and a class “P” stream for 17.4 miles to its confluence with the Spring River in Jasper County. Designated uses for NFSR are “warm water aquatic life protection, livestock and wildlife watering, class B whole body contact recreation, and secondary contact recreation.”

The NFSR is a tributary of the Spring River system in southwestern Missouri that flows through a geological region that is a transitional area that has features of both the Ozark and Central Plains ecoregions (Figure 2). The stream system is characterized by long pools with short, rocky and gravelly riffles, and the geology in the watershed contains beds of shale, sandstone, and limestone (Pflieger 1989). The NFSR has the physical characteristics of a transitional stream upstream of the town of Lamar, changes to a glide/pool (**GP**) dominant stream from Lamar to just upstream of the town of Jasper, and then changes back to a transitional stream as it flows back into the Ozark ecoregion. The GP section of stream tends to have more fine sediment, large amounts of woody debris (**SG**), and a narrower stream channel than the transitional section of the stream. The transitional section of the stream has a wider channel, defined riffles, and coarse substrate (**CS**) abundant in riffle/run habitat.

The Ozark/Neosho EDU has no transitional or GP reference streams, so it was determined that the macroinvertebrate samples collected from the NFSR would be compared to biological criteria calculated from transitional reference streams in the Ozark/Osage EDU or GP reference streams in the Central Plains/Osage/South Grand EDU. An earlier NFSR study (MDNR 2008) used Detrended Correspondence Analysis (**DCA**) to determine if the NFSR macroinvertebrate community was more similar to Little Drywood Creek (**LDC**), a reference stream in the Central Plains/Osage/South Grand EDU or Cedar and Horse creeks, two transitional reference streams in

the Ozark/Osage EDU. The results of this analysis indicated that samples from NFSR test stations #2 - #10 were more similar to the LDC samples and test station #1 was more similar to the two transitional streams. Because of these results, it was determined that test stations #2 - #10 would be compared to the GP Central Plains/Osage/South Grand EDU biological criteria and test station #1 would be compared to biological criteria calculated from the two transitional streams in the Ozark/Osage EDU.

Results from the 2006-2007 study found that four out of eleven samples during the fall 2006 sampling season and four out of ten samples during the spring 2007 sampling season had Macroinvertebrate Stream Condition Index (**MSCI**) scores in the partially supporting range, indicating biological impairment for those samples. During the fall 2006 sampling season, the samples that showed impairment were from GP test stations #4 and #5 and the transitional test station #10 located in the upper part of the watershed. Spring 2007 samples that indicated impairment were collected from the transitional riffle/pool (**RP**) test station #1 located in the lower part of the watershed and test stations #8 - #10 in the upper part of the watershed. The study also showed that dissolved oxygen was very low at multiple sampling stations, and sediment was elevated at some sampling stations.

Earlier biological assessment studies for the upper and lower NFSR in 2003-2004 also indicated that the macroinvertebrate community was impaired (MDNR 2004, 2005a). The habitat assessments conducted on the lower NFSR in the fall of 2004 showed that benthic sediment was elevated in the GP section of NFSR from Lamar to the Highway 126 bridge crossing. A Total Maximum Daily Load (**TMDL**) for the NFSR was completed by the United States Environmental Protection Agency (**USEPA**), Region 7 (USEPA 2006). The TMDL found that turbidity converted to total suspended solids (**TSS**) from water samples collected on the NFSR was elevated compared to the TSS reference condition for the Ozark/Neosho EDU. Reference condition for the TMDL was determined by calculating the 25th percentile of all available data for the Ozark/Neosho EDU. Water quality data from the biological assessment studies and a wasteload allocation study on the Lamar Waste Water Treatment Facility (MDNR 2005b) showed that the NFSR tends to have low dissolved oxygen levels during low flow periods in the summer and early fall. These results indicate that sediment and/or low dissolved oxygen could be the stressors causing the macroinvertebrate community impairment.

1.2 Objectives

1) Assess the biological (macroinvertebrate) integrity of the NFSR.

2) Assess the water quality of the NFSR.

1.3 Tasks

1) Conduct a biological assessment of the macroinvertebrate community on the NSFR at ten test stations during the fall 2012 and spring 2013 sampling seasons.

2) Collect water samples and water quality field measurements at the bioassessment sampling stations.

1.4 Null Hypotheses

1) The macroinvertebrate community will not differ among longitudinally separate reaches of the NFSR.

2) The macroinvertebrate assemblages in the GP NFSR samples will be similar to the Central Plains Osage/South Grand EDU wadeable/perennial stream biological criteria.

3) The macroinvertebrate assemblage in the RP NFSR samples will be similar to criteria calculated from the two transitional RP wadeable/perennial streams from the Ozark/Osage EDU.

4) Physicochemical water quality in the NFSR will meet the WQS of Missouri (MDNR 2014).

5) Physicochemical water quality will not differ among longitudinally separate reaches of the NFSR.

Figure 1
Land Use of the NFSR Watershed

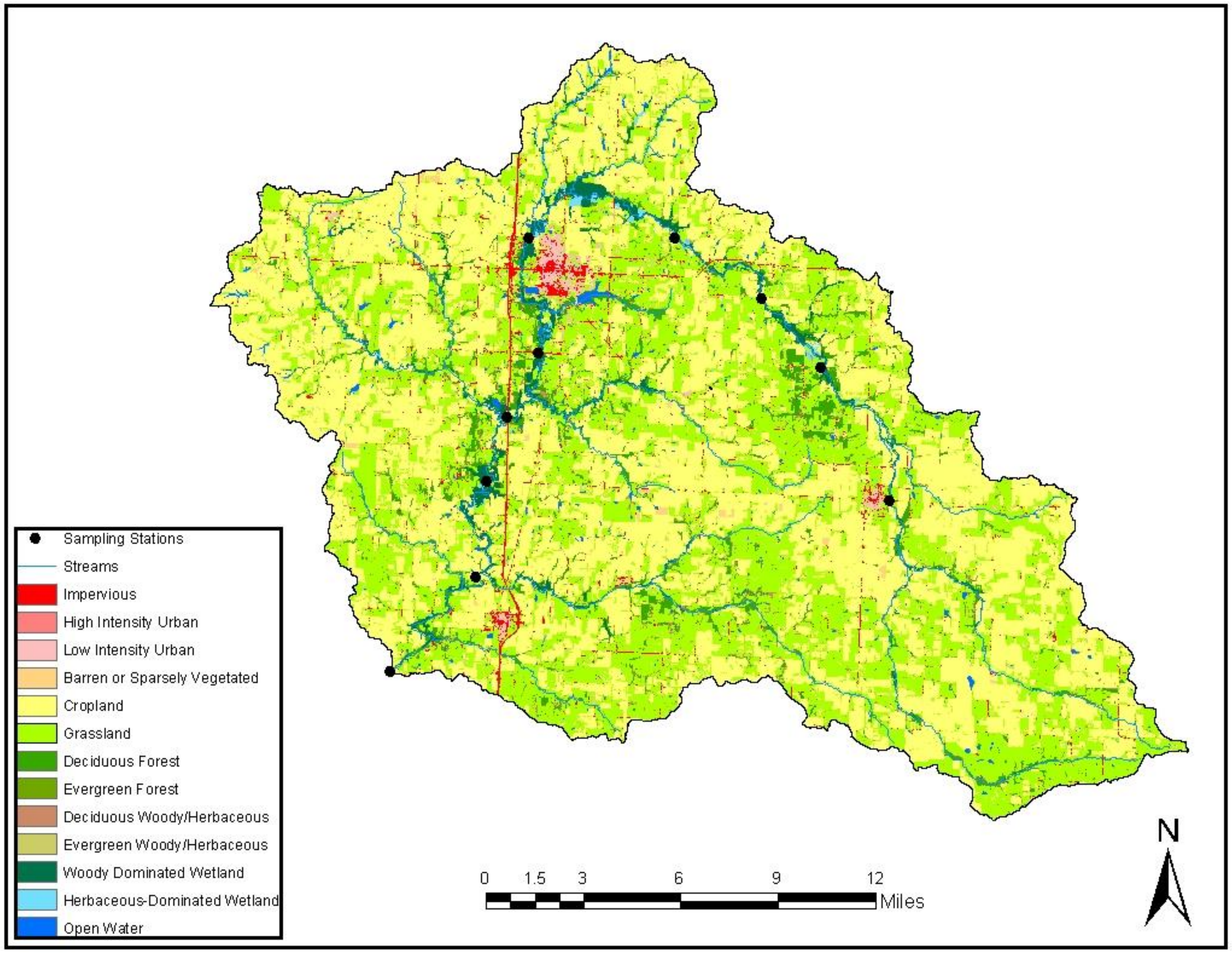
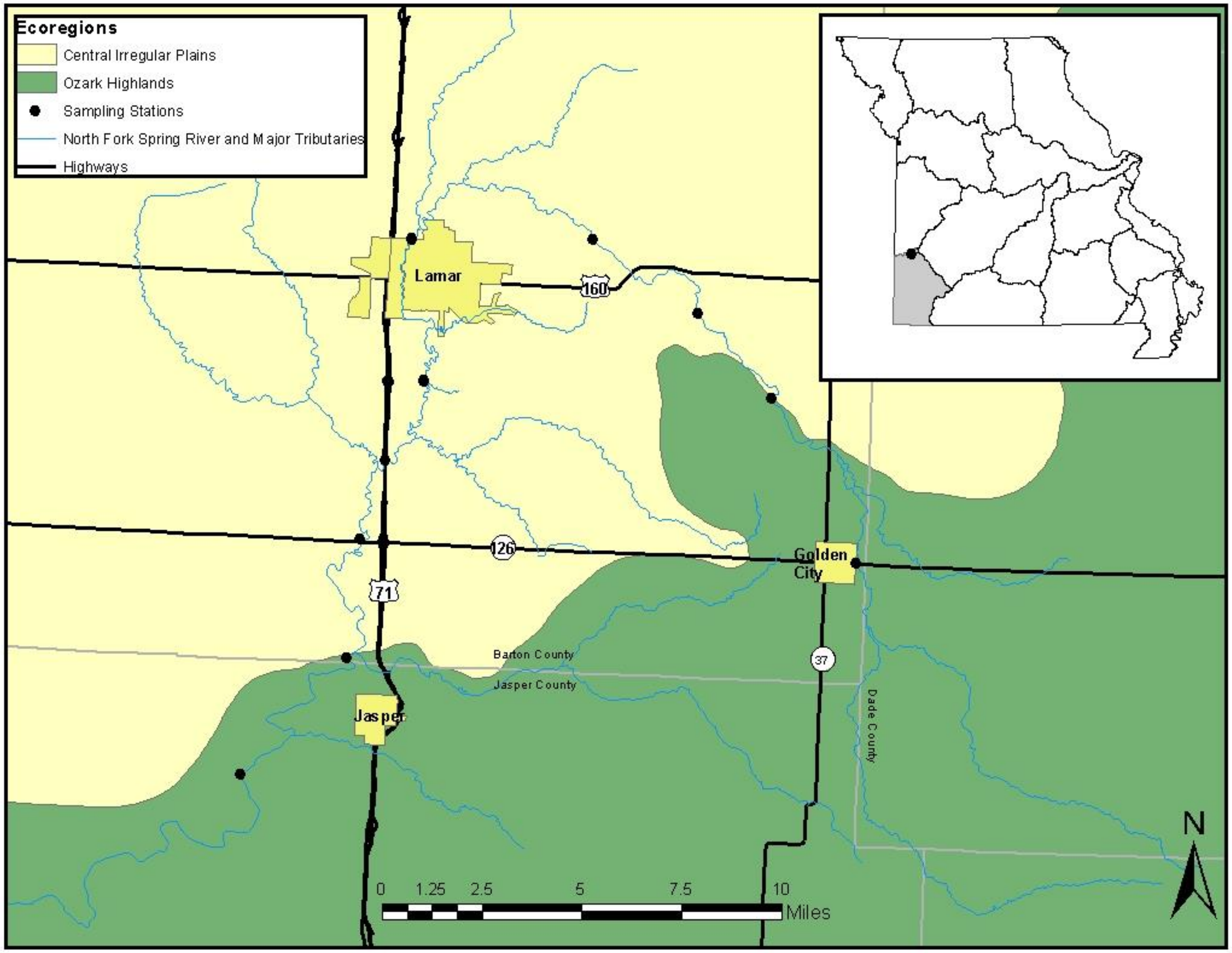


Figure 2
Map of NFSR and Sampling Station Locations



2.0 Methods

Carl Wakefield, Ken Lister, Brandy Bergthold, and Sam McCord of the WQMS, MDNR, Division of Environmental Quality, ESP conducted this study.

2.1 Study Timing

Macroinvertebrate and discrete water quality samples were collected for one fall and one spring season. Fall sampling was conducted on September 25- 27 and October 10, 2012, and spring sampling was conducted on April 16-17 and May 2, 2013.

2.2 Station Descriptions

Ten test stations were sampled for this study. Three test stations that were sampled during the 2006-2007 study, stations #4, #9, and #10, were not resampled for this study because landowners could not be contacted. These test stations were replaced by three nearby test stations (stations #4.5, #8.5, and #9.5). See Figure 2 for a map of the locations of the test stations.

2.2.1 Sampling Stations

NFSR #1: Legal description was SE ¼ Sec. 29, T. 30 N., R. 31 W. Geographic coordinates were Universal Transverse Mercator (**UTM**) zone 15, 379213 Easting, 4130577 Northing. Station #1 was located upstream of Redbud Road in Jasper County. The station had better defined riffle/run segments with a much wider channel and shallower water depths than the other stations. There were rock outcroppings that lined part of the banks, and CS was much more common in all habitats than at the other sampling stations.

NFSR #2: Legal description was SW ¼ Sec. 11, T. 30 N., R. 31 W. Geographic coordinates were UTM zone 15, 383515 Easting, 4135260 Northing. Station #2 was located upstream of SW 100th Road in Barton County. The station was a transitional stream segment with some deep pools with a lot of woody debris and shallow run segments that had rock outcroppings along the bank. It was at this reach that the stream tended to change from a GP stream to a RP stream.

NFSR #3: Legal description was SW ¼ Sec. 26, T. 31 N., R. 31 W. Geographic coordinates were UTM zone 15, 384047 Easting, 4140007 Northing. Station #3 was located upstream of Highway 126 in Barton County. This was a GP station that had a narrow channel width with water depths greater in some of the pools than stations #1 and #2. It had a high abundance of woody debris and was well shaded by riparian trees for much of the sample reach.

NFSR #4.5: Legal description was SE ¼ Sec. 14, T. 31 N., R. 31 W. Geographic coordinates were UTM zone 15, 385051 Easting, 4143156 Northing. Station #4.5 was located upstream of Highway 71 in Barton County. This station was similar in character to station #3, but it generally was deeper.

NFSR #5: Legal description was SE ¼ Sec. 1, T. 31 N., R. 31 W. Geographic coordinates were UTM zone 15, 386616 Easting, 4146343 Northing. Station #5 was located upstream of SE 30th Road in Barton County. This station was a GP station that was similar to stations #3 and #4.5, but it had more benthic sediment and less riparian shading.

NFSR #6: Legal description was NW ¼ Sec. 24, T.32 N., R. 31 W. Geographic coordinates were UTM zone 15, 386123 Easting, 4152030 Northing. Station #6 was located upstream of NE 5th Road in Barton County. This was a transitional station that had short riffle/run segments with very fine CS and pool habitat with some woody debris.

NFSR #7: Legal description was NE ¼ Sec. 22, T.32 N., R. 30 W. Geographic coordinates were UTM zone 15, 393395 Easting, 4152012 Northing. Station #7 was located downstream of NE 50th Road in Barton County. This station had well-defined riffle/run segments with a high abundance of CS covering the stream bottom. This station was downstream of a low water bridge crossing that acted as a dam by impeding water upstream of the crossing. The NFSR upstream of the crossing was pooled up for many miles and had conditions more like a lake than a stream.

NFSR #8: Legal description was NE ¼ Sec. 31, T.32 N., R. 29 W. Geographic coordinates were UTM zone 15, 397665 Easting, 4149040 Northing. Station #8 was located upstream of SE 10th Road in Barton County. This station had two well-defined riffle/run segments at the downstream end of the sampling reach. The remainder of the station was a very long, deep, wide pool that made up at least 2/3 of the sampling reach.

NFSR #8.5: Legal description was NE ¼ Sec. 9, T. 31 N., R. 29 W. Geographic coordinates were UTM zone 15, 400602 Easting, 4145623 Northing. Station #8.5 was located downstream of SE 30th Road in Barton County. The station was made of many short riffle/run segments alternating with pools that were short and shallow. CS was very abundant at this station.

NFSR #9.5: Legal description was SW ¼ Sec. 36, T. 31 N., R. 29 W. Geographic coordinates were UTM zone 15, 404003 Easting, 4139018 Northing. Station #9.5 was located downstream of Highway 160 located east of Golden City. The station was smaller than the other stations and was made up of short riffle/run segments alternating with shallow pools.

2.3 MoRap Aquatic Ecological Classification

The aquatic ecological classification developed by the Missouri Resource Assessment Partnership (**MoRAP**) is a classification system that divides the aquatic resources of Missouri into distinct regions. It has seven levels of classification starting at large regions, which are then divided into smaller sub-regions (Sowa et al. 2004). The following are the seven levels of classification in hierarchical order: zone, subzone, region, aquatic subregions, EDU, Aquatic Ecological Systems (**AES**), and Valley Segment Types (**VST**). The levels of classification are based on biology, zoogeography, taxonomic composition, geology, soils, and groundwater connection. Some levels of the hierarchical system use geology and soils to classify, and other levels use biology and taxonomic composition of aquatic communities. EDUs and AES are the two levels of classification that will be assessed in detail for this study.

2.3.1 Ecological Drainage Unit

The EDU is level five of the classification hierarchy, and it is based on geographical variation of the taxonomic composition of the level four subregions. An EDU is a region in which aquatic biological communities and habitat conditions can be expected to be similar. All of the NFSR sampling stations are within the Ozark/Neosho EDU (Figure 2 inset). Table 1 compares the land cover percentages from the Ozark/Nesoho EDU, the ten NFSR test stations, the two transitional biocriteria reference streams from the Ozark/Osage EDU, and LDC, a biocriteria reference stream in the Central Plains/Osage/South Grand EDU. Figure 1 shows the landcover percentages for the NFSR watershed. Land cover data used in figure 1 and table 1 were derived from Thematic Mapper satellite data from 2000 to 2004 and by MoRAP. Cropland was the dominant land use of the NFSR watershed, making up about 50 percent of the land use at all of the test stations. The NFSR cropland percentages were higher than the values from the reference sampling stations in the Ozark/Neosho EDU, Central Plains/Osage/South Grand EDU, Cedar Creek, and Horse Creek. Grassland and forest were present in much lower percentages at the NFSR test stations than the overall Ozark/Neosho EDU and the biological criteria reference stations.

2.3.2 Aquatic Ecological Systems

AES are level six of the classification hierarchy. At this level aquatic systems are classified into AES types based on geology, soils, landform, and groundwater influence. AES boundaries can cross over EDU boundaries in transitional areas that have similar geology and soils. NFSR and LDC are located in the South Deepwater Creek AES (Figure 3). The South Deepwater Creek AES type generally has local relief less than 100 feet and has soil surface textures made primarily of silt loams with very slow to moderate infiltration rates (Sowa and Diamond 2006). Sandstone and shale are the dominant deposits in this AES type, and these deposits impede downward water movement. Most of the water making up stream discharge in this AES type comes from surface flow since springs are not very abundant. Even among the larger watersheds, the streams in this AES type tend to have very low flows because of low infiltration rates and the lack of springs.

The AES type for the Horse Creek watershed is Clear Creek, an adjacent Osage River tributary. This AES type is a transition area between the Central Till Plains, Osage Plains, and the Ozark aquatic subregions. Local relief ranges from nearly zero to 200 feet, but most areas are between 50 to 100 feet. Bedrock geology is primarily Pennsylvanian limestone and has soil surface textures made of silty loams and loams with moderate to sometimes very slow infiltration rates. Streams in this AES type have their highest flows in the spring and occasionally go nearly dry during dry periods in the summer and fall. Springs are not common, but groundwater is abundant and often saline.

The Cedar Creek watershed and lower Spring River watershed that receives the NFSR are located in the Moniteau Creek AES type. Local relief ranges from nearly zero to 200 feet. Bedrock consists primarily of Mississippian and Pennsylvanian cherty limestones. Karst features including sinkholes are scattered in this AES type, and groundwater is abundant. Surface soil

textures in the Moniteau Creek AES type are primarily loams or silty loams with slow to moderate infiltration rates. Stream bed loads are made of gravel and sand.

Figure 3
AES Types for Cedar Creek, Horse Creek, Little Drywood Creek, North Fork Spring River and the Lower Spring River

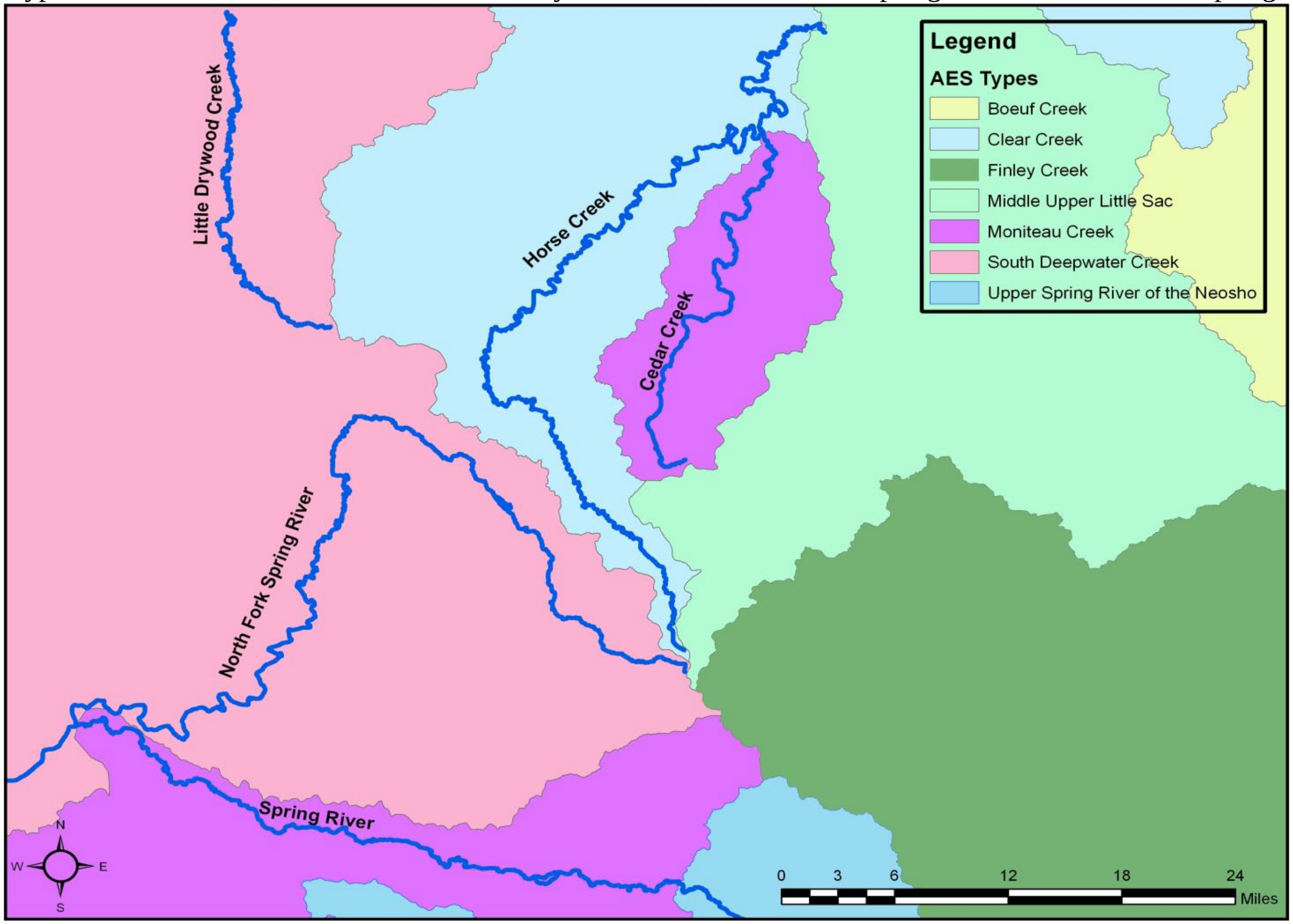


Table 1

Percent Land Cover

Land cover	Ozark/ Neosho EDU	Little Drywood Creek	Horse Creek	Cedar Creek	NFSR #1	NFSR #2	NFSR #3	NFSR #4.5	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Impervious	2.6	1.6	0.8	0.4	1.9	1.9	2.0	2.1	2.1	1.4	1.2	1.1	1.1	0.9
High Intensity Urban	0.2	0.003	0.01	0	0.02	0.02	0.03	0.04	0.05	0.02	0.002	0.002	0.002	0.002
Low Intensity Urban	1.9	0.4	0.3	0.1	0.8	0.8	0.9	1.1	1.3	0.7	0.4	0.4	0.5	0.3
Barren/Sparsely Vegetated	0.6	0.2	0.1	0.04	0.4	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
Cropland	15.2	23.9	18.5	14.1	50.3	51.3	52.5	49.3	50.1	52.6	50.2	50.4	51.8	50.8
Grassland	52.8	52.9	53.9	65.5	37.4	36.2	34.7	37.2	36.1	35.7	39.6	39.7	39.5	41.8
Deciduous Forest	20.3	9.8	16.4	13.5	3.9	4.0	3.8	4.1	4.0	3.6	4.2	4.3	3.7	2.9
Evergreen Forest	0.1	0.1	0.2	0.2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01
Deciduous Woody/Herbaceous	4.8	3.3	4.2	5.0	1.9	1.9	1.7	1.8	1.7	1.6	1.7	1.6	1.6	1.5
Evergreen Woody/Herbaceous	0.01	0.006	0.02	0.01	0.007	0.007	0.007	0.007	0.002	0.001	0.002	0.001	0.001	0.001
Woody Dominated Wetland	0.9	5.8	4.3	0.6	2.2	2.3	2.4	2.6	2.8	2.6	1.5	1.4	0.9	0.8
Herbaceous-Dominated Wetland	0.2	0.9	0.5	0.1	0.4	0.4	0.4	0.5	0.6	0.5	0.2	0.2	0.1	0.1
Open Water	0.5	1.1	0.8	0.4	0.8	0.8	0.9	0.9	1.0	0.8	0.6	0.6	0.5	0.6

2.4 Biological Assessment

Biological assessments consist of macroinvertebrate collection and surface water physicochemical sampling for two sample periods.

2.4.1 Macroinvertebrate Collection and Analysis

A standardized macroinvertebrate sample collection and analysis procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**, MDNR 2012). Three standard habitats, flowing water over CS, depositional substrate in non-flowing water (**NF**), and rootmat (**RM**) were collected at RP sampling stations. For GP samples, NF, SG, and RM were collected.

Macroinvertebrates were identified in accordance with standard operating procedure MDNR-ESP-209, Taxonomic Levels in Macroinvertebrate Identifications (MDNR 2010a). Macroinvertebrate data were analyzed using two methods. The first analysis was calculating MSCI scores for each station using the four general biological metrics found in the SMSBPP (MDNR 2002, 2012). The four metrics used are: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**). The metric evaluations were done by comparing the NFSR test stations on a seasonal basis to the biological criteria for the Central Plains/Osage/South Grand EDU or criteria calculated from the two transitional streams in the Ozark/Osage EDU, Cedar and Horse creeks.

The second analysis of the biological data was an evaluation of macroinvertebrate community composition by percent composition of EPTT, sensitive taxa, functional feeding groups (**FFG**), functional habit groups (**FHG**), and dominant macroinvertebrate families and taxa. Values for FFGs were based on the primary FFG designations. Primary FFG designations are either the first or the only FFG listed in reference publications for each taxon (Barbour et al. 1999, Kentucky Division of Water 2009, Merritt and Cummins 2008). Also, NFSR macroinvertebrate community attributes were compared to wadeable/perennial biological criteria.

2.5 Physicochemical Water Sample Collection and Analysis

Discrete physicochemical samples collected in fall 2012 and spring 2013 included pH, temperature, conductivity, dissolved oxygen, discharge, non-filterable residue (**NFR**), turbidity, ammonia-N, nitrate+nitrite-N, total nitrogen, total phosphorus, chloride, sulfate, total calcium, and total magnesium. Temperature, pH, conductivity, dissolved oxygen, and discharge were measured in the field. All samples were collected per MDNR-ESP-001, Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2011) and kept on ice until they were delivered to the ESP laboratory. Required descriptive information for each sample was recorded on a chain-of-custody form per MDNR-ESP-002, Field Sheet and Chain-of-Custody Record (MDNR 2010b).

2.5.1 Discharge

Stream flow was measured using a Marsh-McBirney flow meter at each station and discharge was calculated as cubic feet per second (cfs). Methodology was in accordance with the standard operating procedure MDNR-ESP 113, Flow Measurement in Open Channels (MDNR 2013).

2.6 Data Analysis and Quality Control

The physicochemical data were examined by analyte to determine whether NFSR stations had violations of the Missouri WQS (MDNR 2014). Sampling stations that had values not in compliance with the WQS or recommended U.S. Environmental Protection Agency (USEPA) recommended reference values are discussed in this report and possible influences are identified.

3.0 Results

3.1 Macroinvertebrate Biological Assessment

3.1.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure

Fall 2012 Sampling Season

Cedar and Horse creeks, which are two biological criteria reference streams in a transitional area of the Ozark/Osage EDU, were used to calculate RP criteria to assess NFSR #1 during the fall 2012 sampling season (Table 2). All other NFSR test stations were assessed using GP biological criteria from the Central Plains/Osage/South Grand EDU (Table 3).

All of the NFSR test stations except the two most upstream stations had MSCI scores in the fully supporting range during the fall 2012 sampling season (Tables 2 and 3). Stations #8.5 and #9.5 had partially supporting MSCI scores of 14. Test station #1 was assessed using both sampling regimes so it could be compared to the other sampling stations. To accomplish this comparison, all four habitats (CS, NF, RM, SG) were collected at NFSR #1. When using RP criteria, NFSR #1 had an MSCI score of 16 and a score of 20 when using GP criteria. With the exception of NFSR #2, which had an MSCI score of 20, the remaining sampling stations had MSCI scores of 16. Most of the study stations had at least one biological metric value that was lower than the optimum biological criteria range. During the fall 2012 sample season, the SDI was sub-optimal at six GP stations, BI was sub-optimal at eight GP stations, and the NFSR #1 RP station also was sub-optimal for BI. Three of the four most upstream stations had sub-optimal EPTT values compared to GP criteria.

Table 2
Fall 2012 Ozark/Osage EDU Transitional Stream Riffle/Pool Biological Criteria, Biological Support Categories, and MSCI Scores for the NFSR Sampling Stations

Stream and Station Number	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
NFSR #1	120107	80	13	**7.0**	**3.13**	16	F
Metric Score=5	If	>77	>11	<6.9	>3.13	20-16	**F**ull
Metric Score=3	If	77-39	11-6	6.9-8.5	3.13-1.57	14-10	**P**artial
Metric Score=1	If	<39	<6	>8.5	<1.57	8-4	**N**on

MSCI Scoring Table (in light gray) developed from BIOREF streams (n=6); TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index. Values in bold indicate a sub-optimal score for that biological metric.

Table 3
Fall 2012 Riffle/Pool Ozark/Neosho EDU and Glide/Pool Central Plains/Osage/South Grand EDU Stream Biological Criteria, Biological Support Categories, and MSCI Scores for the NFSR Sampling Stations

Station	**Sample No.**	**TR**	**EPTT**	**BI**	**SDI**	**MSCI**	**Support**
Riffle/Pool Ozark/Neosho EDU Biological Criteria							
NFSR #1	120107	80	**13**	**7.0**	3.13	16	**F**
Metric Score=5	If	>77	>24	<5.5	>2.97	20-16	**F**ull
Metric Score=3	If	77-39	24-12	5.5-7.7	2.97-1.49	14-10	**P**artial
Metric Score=1	If	<39	<12	>7.7	<1.49	8-4	**N**on
Glide/Pool Central Plains/Osage/South Grand EDU Biological Criteria							
NFSR #1	120107	71	11	7.4	2.87	20	F
NFSR #2	120104	64	7	7.5	2.98	20	F
NFSR #3	120105	63	7	**7.7**	**2.67**	16	F
NFSR #4.5	120109	63	8	**7.6**	**2.39**	16	F
NFSR #5	120108	61	8	**7.7**	**2.79**	16	F
NFSR #6	120114	63	7	**7.8**	**2.81**	16	F
NFSR #7	120103	69	**5**	**7.7**	2.98	16	F
NFSR #8	120102	61	**5**	**7.6**	2.86	16	F
NFSR #8.5	120106	**55**	7	**7.6**	**1.89**	14	**P**
NFSR #9.5	120113	60	**3**	**7.6**	**2.52**	14	**P**
Metric Score=5	If	>55	>6	<7.6	>2.85	20-16	**F**ull
Metric Score=3	If	55-28	6-3	7.6-8.8	2.85-1.42	14-10	**P**artial
Metric Score=1	If	<28	<3	>8.8	<1.42	8-4	**N**on

MSCI Scoring Table (in light gray) developed from Ozark/Neosho EDU BIOREF streams (n=10) and Central Plains/Osage/South Grand EDU BIOREF streams (n=15); TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index. Values in bold indicate a sub-optimal score for that biological metric.

Spring 2013 Sampling Season
Macroinvertebrate samples were not collected at test stations #2-#4.5 because of high water levels during the spring 2013 sampling season. The remaining test stations were assessed using GP biological criteria from the Central Plains/Osage/South Grand EDU. Although NFSR #1 was assessed using RP criteria in fall 2012, GP criteria were used in spring because high water levels prevented CS habitat from being sampled (Table 4). All of the test stations except NFSR #6 either had partially supporting MSCI scores of 14 or fully supporting scores of 16. The EPTT metric values and scores at these test stations were the difference between partially and fully supporting MSCI scores. Stations that had MSCI scores of 14 had EPTT values of 3 (metric score = 1), whereas stations that had MSCI scores of 16 had EPTT values of 4 (metric score = 3). Test station #6 had an MSCI score of 12, which was caused by three of the metrics (TR, EPTT, and BI) having sub-optimal values compared to the criteria. All of the test stations had low values for EPTT and high values for BI, which led to lower scores for the two metrics.

Table 4
Spring 2013 Glide/Pool Central Plains/Osage/South Grand EDU Stream Biological Criteria, Biological Support Categories, and MSCI Scores for the NFSR Sampling Stations

Station	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
NFSR #1	131916	67	**3**	**7.6**	3.03	14	P
NFSR #5	131914	55	**4**	**8.2**	2.95	16	F
NFSR #6	131917	**38**	**3**	**8.4**	2.54	12	P
NFSR #7	131918	62	**3**	**7.9**	3.13	14	P
NFSR #8	131919	58	**4**	**7.7**	2.96	16	F
NFSR #8.5	131920	58	**4**	**7.9**	2.71	16	F
NFSR #9.5	131921	59	**3**	**7.8**	3.00	14	P
Metric Score=5	If	>50	>8	<7.3	>2.53	20-16	**F**ull
Metric Score=3	If	50-25	8-4	7.3-8.7	2.53-1.27	14-10	**P**artial
Metric Score=1	If	<25	<4	>8.7	<1.27	8-4	**N**on

MSCI Scoring Table developed from Central Plains/Osage/South Grand EDU BIOREF streams (n=12); TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index. Values in bold indicate a sub-optimal score for that biological metric.

3.1.2 Macroinvertebrate Percent and Community Composition

The percent composition of sensitive taxa, FFG, EPTT, and the five dominant macroinvertebrate families and taxa at each station are presented in Figures 4-7 and Tables 5-9. FHG were not analyzed for this study because many of the taxa found in the samples were non-insect taxa that

do not have FHGs assigned to them. Values in bold type represent the five dominant macroinvertebrate families and taxa for each station.

Fall 2012 Sampling Season

The BI range of the fall 2012 NFSR #1 RP sample was more similar to the Ozark/Osage transitional biological criteria streams than the Ozark/Neosho biological criteria streams (Figure 4 and Table 5). Although NFSR #1 had a higher abundance of tolerant taxa than both reference datasets, tolerant taxa were much more abundant than the Ozark/Neosho EDU biological reference streams. Taxa that had BI values >4.9 were more abundant in NFSR #1 and the Ozark/Osage transitional biological criteria reference streams than the Ozark/Neosho biological criteria reference streams. The Ozark/Neosho biological criteria reference streams had a higher abundance of sensitive taxa, which led to a higher percentage of taxa with BI values <5.0.

Samples from test stations #2-#9.5 were assessed as GP streams and were compared to the Central Plains/Osage/South Grand EDU biological reference streams (Figure 4 and Table 5). These samples had a high abundance of tolerant organisms with most of the taxa having BI values >4.9. The proportion of NFSR GP samples in the very tolerant range (BI>8.9) was generally lower than the Central Plains/Osage/South Grand EDU reference streams; however, NFSR samples in the tolerant range (BI 7.5-8.9) were slightly to much higher. The majority of GP NFSR stations also had a slightly lower percentage of moderately tolerant (BI 5.0-7.4), intolerant (BI 2.5-4.9), and very intolerant taxa (BI < 2.5) than the reference streams.

Gatherer-collectors and filterers were the two most abundant FFGs at the RP NFSR #1 station in fall 2012 (Figure 5 and Table 5). Gatherer-collectors were more abundant at NFSR #1 than the Ozark/Neosho EDU and the Ozark/Osage EDU transitional biological criteria reference data. Filterers were similar in abundance at station #1 compared to the Ozark/Osage EDU transitional streams, but they were present in higher numbers than the Ozark/Neosho EDU biological criteria reference streams. Shredders were the third most abundant FFG at station #1 and were similar to the Ozark/Osage EDU transitional streams, but they were more numerous than the Ozark/Neosho EDU biological criteria reference streams. Scrapers made up 8.5 percent of the sample at station #1, which was much lower than the Ozark/Neosho EDU biological criteria streams and about five percentage points lower than the Ozark/Osage EDU transitional streams. Predators made up about eight percent of the NFSR #1 sample, which was similar to Ozark/Neosho EDU biological criteria streams but lower than the Ozark/Osage EDU transitional streams.

Gatherer-collectors were the most abundant FFG at the nine NFSR GP stations during the fall 2012 sampling season. Among these nine stations, gatherer-collector abundance ranged from about 50 percent at station #2 and #8 to about 79 percent at NFSR #8.5 (Figure 5 and Table 5). The percent gatherer-collector FFG among NFSR GP stations ranged from slightly higher to much higher than the Central Plains/Osage/South Grand EDU biological criteria data. The second most upstream station (station #8.5) and the stations at and downstream of Lamar had the highest gatherer-collector percentages. Filterers at the NFSR GP stations ranged from about two percent at NFSR #8.5 to 15 percent at NFSR #2. The percent of filterers at the NFSR stations upstream of Lamar was lower than the Central Plains/Osage/South Grand EDU biological

criteria data, but the stations at and downstream of Lamar had a higher percentage of filterers than reference conditions. The percent of scrapers present among NFSR GP stations was much lower than the Central Plains/Osage/South Grand EDU biological criteria data, with the exception of NFSR #9.5, in which this metric was only slightly lower. Among NFSR GP stations, percent shredders ranged from much lower to slightly higher than reference conditions. The percent of shredders at the first three stations downstream of Lamar (NFSR #3-#5) and NFSR #8.5 was lower, but three upstream NFSR stations (NFSR #7, #8, and #9.5) had a higher percentage of shredders than reference conditions. Among NFSR GP stations, predators ranged from about eight percent at NFSR #8.5 to about 21 percent at NFSR #3. The three most downstream GP stations and NFSR #8 had the highest values for percent predators and were higher than reference conditions.

Figure 4
Percent of Taxa by Biotic Index Range for the NFSR, the Ozark/Neosho EDU Biological Reference Streams, the Ozark/Osage Transitional Biological Criteria Reference Streams, and the Central Plains/Osage/South Grand EDU Biological Reference Streams, Fall 2012

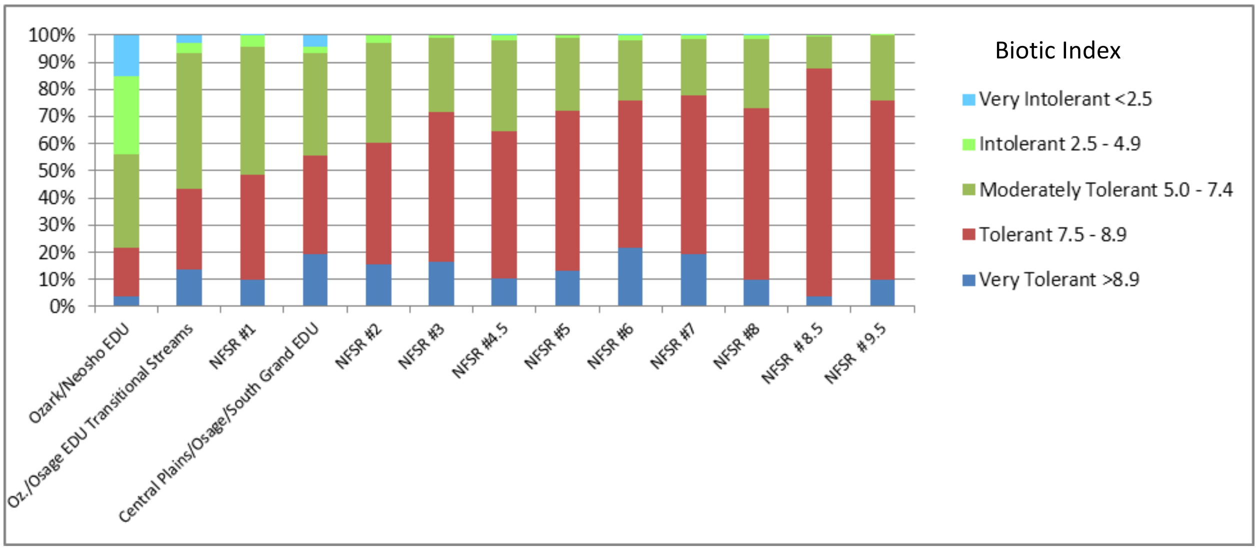


Figure 5
Percent of Taxa by Functional Feeding Group for the NFSR, the Ozark/Neosho EDU Biological Reference Streams, the Ozark/Osage Transitional Biological Criteria Reference Streams, and the Central Plains/Osage/South Grand EDU Biological Reference Streams, Fall 2012

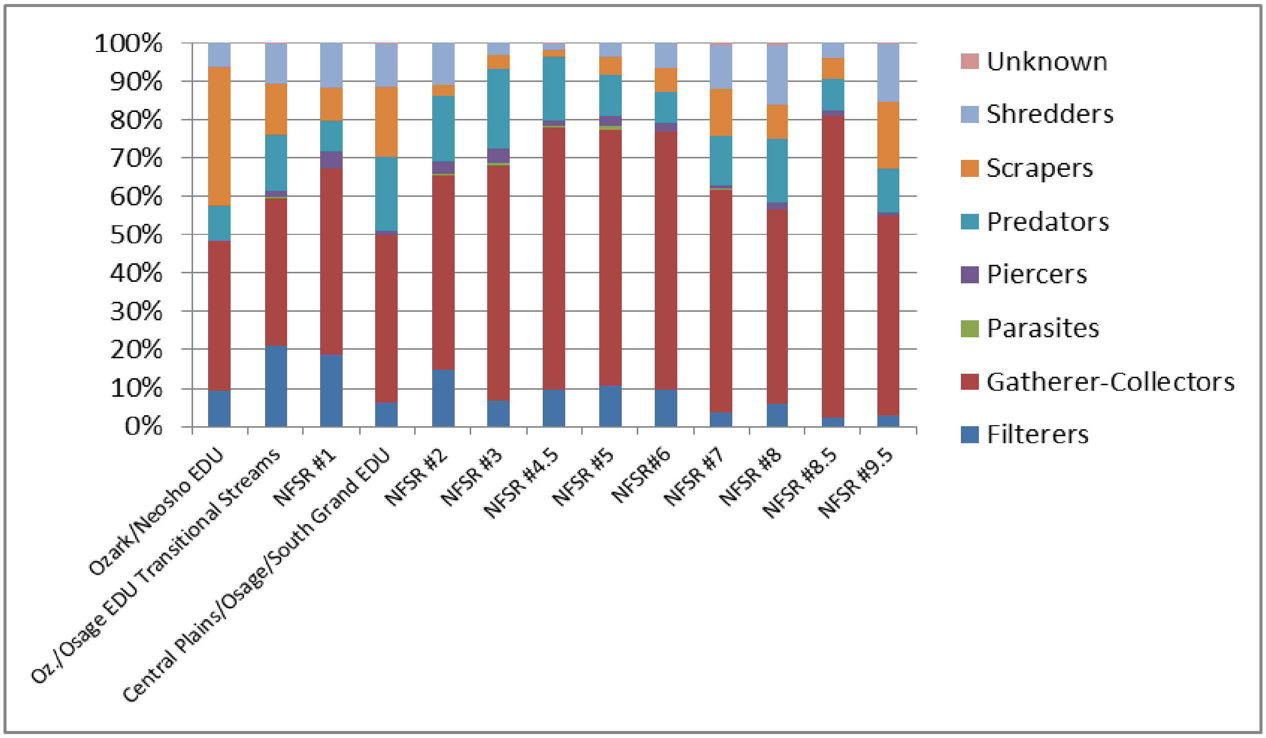


Table 5
Sensitive Taxa and FFG at the NFSR Test Stations and the Reference Samples from the Ozark/Nesoho EDU, Central Plains/Osage/South Grand EDU, and the Ozark/Osage Transitional Reference Streams, Fall 2012

Variable-Station	Oz./Neosho EDU Biocriteria Reference Streams	Oz./Osage EDU Transitional Reference Streams	NFSR #1	CP/O/SG EDU Biocriteria Reference Streams	NFSR #2	NFSR #3	NFSR #4.5	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Sample Number			120107		120104	120105	120109	120108	120114	120103	120102	120106	120113
Sensitive Taxa													
% Biotic Index >9.0	3.6	13.6	9.9	19.2	15.6	16.7	11.6	13.1	21.9	19.1	10.1	3.6	10.0
% Biotic Index 7.5-9.0	18.3	29.8	38.5	36.6	44.6	54.8	60.5	58.8	54.0	58.6	63.2	84.0	65.7
% Biotic Index 5.0-7.5	34.2	49.8	47.5	37.5	36.7	27.3	25.5	27.1	22.2	21.0	25.1	12.1	24.1
% Biotic Index 2.5-5.0	28.9	3.9	4.0	2.3	3.1	1.2	2.1	0.9	1.8	1.2	1.4	0.3	0.2
% Biotic Index <2.5	15.0	2.9	0.1	4.4			0.3		0.1	0.1	0.2		
FFG Metrics													
% Filterers	9.2	21.1	19.0	6.2	14.8	6.8	9.5	10.6	9.6	3.8	5.9	2.2	3.0
% Gatherer-Collectors	39.2	38.7	48.2	43.6	50.6	61.5	68.4	66.7	67.4	58.1	50.6	78.8	52.0
% Parasites	0.02	0.03	0.1	0.02	0.3	0.6	0.3	0.9	0.1	0.1			0.1
% Piercers	0.02	1.6	4.3	1.4	3.3	3.6	1.7	2.9	1.9	0.9	2.0	1.5	0.6
% Predators	9.3	14.7	8.3	19.1	17.3	20.8	16.6	10.5	8.4	13.0	16.5	8.0	11.5
% Scrapers	35.9	13.4	8.5	18.4	2.9	3.8	1.9	5.0	6.2	12.1	8.9	5.5	17.5
% Shredders	6.2	10.6	11.5	11.3	10.8	3.1	1.5	3.4	6.5	11.5	15.6	3.9	15.2
% Unknown		0.05	0.03	0.07	0.03	0.04	0.1			0.5	0.5	0.02	0.1

During the fall 2012 sampling season, percent EPTT at RP station NFSR #1 was similar to the Ozark/Osage transitional biological criteria reference streams, but this metric was much lower than the Ozark/Neosho biological criteria reference streams (Table 6). Ephemeroptera made up most of the EPTT abundance at NFSR #1, but percent Trichoptera was much lower than both biocriteria reference datasets. Plecoptera were found in low abundance in both reference datasets but were not found in the NFSR #1 fall 2012 sample.

Among the nine GP stations sampled in fall 2012, percent EPTT at NFSR #2 - #4.5 and NFSR #8 was much lower than the other test stations and the Central Plains/Osage/South Grand EDU biological criteria streams (Table 7). The other NFSR test stations had percent EPTT values that ranged from slightly higher to much higher than reference conditions. Ephemeroptera made up most of the EPTT abundance at the NFSR GP stations. Ephemeroptera abundance was much lower at the three most downstream GP stations, which led to lower EPTT values at those sampling stations. Trichoptera were found in low abundance at all of the test stations, ranging from 0.1 to 2.5 percent of the samples. Although Plecoptera were absent in all of the NFSR stations, they were also absent from the Central Plains/Osage/South Grand EDU biological criteria reference streams.

The NFSR #1 RP station had more dominant macroinvertebrate taxa in common with the Ozark/Osage transitional biological criteria reference streams than the Ozark/Neosho biological criteria streams (Table 6). Chironomidae was the most abundant family at NFSR #1 and the Ozark/Osage EDU transitional streams, and they were much higher in abundance than the Ozark/Neosho biological criteria reference streams. The most common chironomid found in the NFSR #1 and the Ozark/Osage transitional streams was *Tanytarsus*, which made up about 16 percent of the sample at NFSR #1 and about seven percent of Ozark/Osage EDU transitional streams. Other taxa that were common at NFSR #1 and the Ozark/Osage EDU transitional streams were the amphipod *Hyalella azteca*, the caenid mayfly *Caenis latipennis*, and the riffle beetle *Stenelmis*. *Hyalella azteca* was also common in the Ozark/Neosho biological criteria streams, but this species was more abundant at NFSR #1 than both reference datasets. There were some taxa that were common only at NFSR #1 or Ozark/Osage EDU transitional biological criteria reference streams. The leptohyphid mayfly *Tricorythodes* was much more abundant in NFSR #1, whereas the hydropsychid caddisfly *Cheumatopsyche* and the chironomid *Polypedilum flavum* were more abundant in the Ozark/Osage EDU transitional streams. There were more differences in dominant taxa when comparing NFSR #1 with the Ozark/Neosho EDU biological criteria streams. The water penny *Psephenus herricki*, leptophlebiid mayflies, *Cheumatopsyche*, and the baetid mayfly *Baetis* all were much more abundant in the Ozark/Neosho EDU biological criteria streams than NFSR #1.

Table 6
Percent EPTT, Dominant Macroinvertebrate Families, and Taxa at the Riffle/Pool NFSR #1 Test Station, Ozark/Neosho EDU Biological Criteria Reference Samples, and the Ozark/Osage EDU Transitional Biological Criteria Reference Samples, Fall 2012

Variable-Station	Biotic Index	Osage/Neosho EDU Reference Streams	Ozark/Osage EDU Transitional Reference Streams	NFSR #1
Sample Number				120107
EPTT Metrics (%)				
EPTT		37.5	28.9	25.9
Ephemeroptera		23.9	17.7	24.1
Plecoptera		2.0	0.01	
Trichoptera		11.5	11.2	1.8
Percent Dominant Families				
Psephenidae		**16.7**		0.2
Chironomidae		**12.9**	**31.3**	**37.7**
Heptageniidae		**8.8**	5.5	2.7
Hyalellidae		**8.2**	**9.0**	**12.6**
Elmidae		**7.5**	**8.5**	**5.7**
Hydropsychidae		5.3	**8.7**	0.5
Caenidae		3.4	**8.4**	**8.2**
Leptohyphidae		0.2	0.2	**12.7**
Percent Dominant Taxa				
Psephenus herricki	2.5	**15.9**		0.1
Hyalella azteca	7.9	**8.2**	**9.0**	**12.6**
Leptoplebiidae	2.0	**6.0**	2.5	0.1
Cheumatopsyche	6.6	**4.8**	**8.7**	0.5
Baetis	6.0	**3.2**	0.2	
Caenis latipennis	7.6	3.1	**8.4**	**8.2**
Tanytarsus	6.7	1.7	**6.3**	**16.1**
Polypedilum flavum	5.3	1.3	**5.9**	2.3
Stenelmis	5.4	3.1	3.9	**5.0**
Tricorythodes	5.4	0.2	0.2	**12.7**

Although Chironomidae were common in most of the NFSR GP stations, ranging from 12 to 49 percent of the samples, most of the test stations had lower chironomid abundance than Central Plains/Osage/South Grand EDU reference streams (Table 7). Two chironomids, *Dicrotendipes* and *Glyptotendipes*, were common in the Central Plains/Osage/South Grand EDU biological criteria reference streams and most of the NFSR GP stations. The only exceptions were the low numbers for *Dicrotendipes* at NFSR #7 and *Glyptotendipes* at NFSR stations #3-#6. Other chironomids common at some NFSR stations included *Tanytarsus*, *Procladius*, and *Ablabesmyia*. *Ablabesmyia* and *Procladius* were common at NFSR #4.5 and *Tanytarsus* was common at NFSR #2, #4.5-#6, and #8. These chironomid taxa also were found in the Central Plains/Osage/South Grand EDU reference samples but in lower abundance than the NFSR stations. Two other taxa that tended to be much more abundant among test stations than reference sites were the amphipod *Hyalella azteca* and the caenid mayfly *Caenis latipennis*. *Hyalella azteca* was one of the most abundant taxa at all of the test stations, making up from about ten percent of the sample at NFSR #6 to about 39 percent at NFSR #3. *Caenis latipennis*

was very abundant in all samples except the three most downstream GP stations (NFSR #2 - #4.5). *Caenis latipennis* made up from about 19 percent to 54 percent of samples in the reach between NFSR #5 and #9.5, which was much higher than reference conditions for the Central Plains/Osage/South Grand EDU. Other taxa that were common in some of the NFSR GP stations were tubificid worms, water mites (Acarina), hydrobiid snails, and the planorbid snail *Helisoma*. Tubificid worms were common in the Central Plains/Osage/South Grand EDU biological criteria reference samples and in the NFSR samples from test stations #2, #3, and #5-#7. Acarina were common at test stations #3 and #8 - #9.5. Hydrobiid snails were common at NFSR #7, and *Helisoma* was common at NFSR #9.5. Heptageniid mayflies, especially *Stenacron*, were much more common in the Central Plains/Osage/South Grand EDU biological criteria reference streams than the NFSR stations.

Table 7
Percent EPTT, Dominant Macroinvertebrate Families, and Taxa at the Glide/Pool NFSR Test Stations, and the Central Plains/Osage/South Grand EDU Biological Criteria Reference Samples, Fall 2012

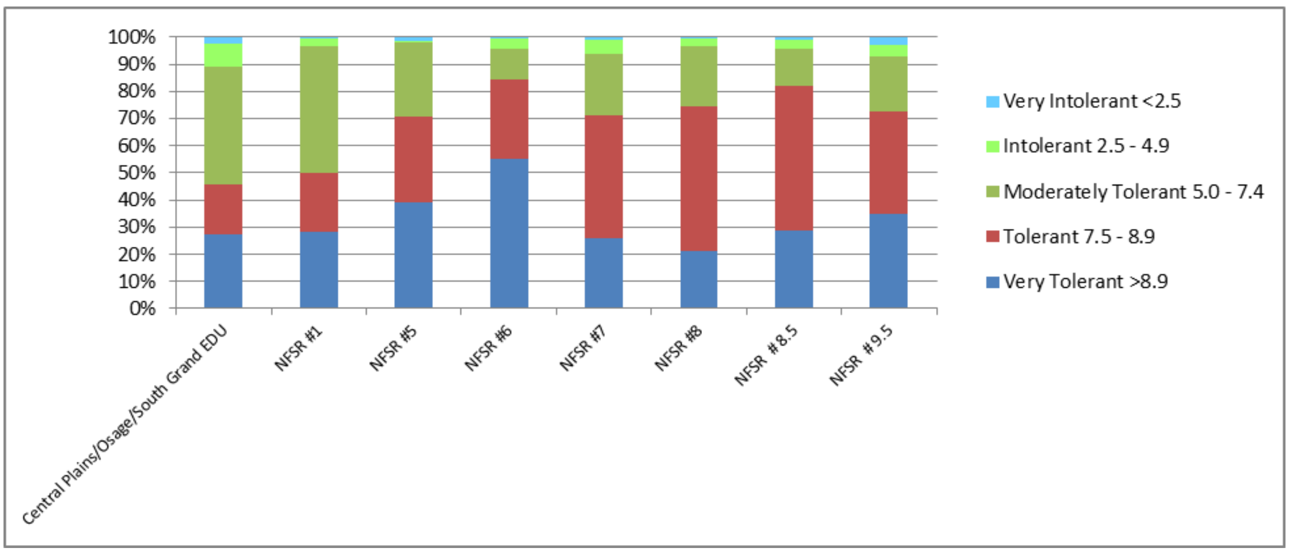
Variable-Station	Biotic Index	CP/O/SG Reference Streams	NFSR #2	NFSR #3	NFSR #4.5	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Sample Number			120104	120105	120109	120108	120114	120103	120102	120106	120113
EPTT Metrics (%)											
EPTT		20.8	5.0	5.7	3.5	22.8	28.4	24.5	10.9	55.6	41.8
Ephemeroptera		19.2	3.9	3.2	2.1	21.6	28.2	24.3	10.8	54.8	41.8
Trichoptera		1.6	1.0	2.5	1.4	1.2	0.2	0.2	0.1	0.8	
Percent Dominant Families											
Chironomidae		**37.0**	**48.8**	**25.0**	**40.4**	**27.9**	**35.8**	**29.0**	**33.1**	**12.0**	**30.3**
Hyalellidae		**4.4**	**20.6**	**39.3**	**42.0**	**26.5**	**9.8**	**15.6**	**25.8**	**17.8**	
Caenidae		**5.9**	1.1	1.6	0.5	**19.4**	**26.7**	**24.0**	**10.1**	**54.3**	**38.6**
Heptageniidae		**8.3**	0.2	1.1	0.2	1.8	1.2	0.3	0.2	0.4	3.2
Tubificidae		**9.0**	**10.8**	**11.4**	**3.9**	**6.6**	**12.2**	**8.9**	**4.7**	0.4	0.9
Baetidae		0.5	**2.7**	0.5	1.4	0.4	0.3	0.2	0.5	0.2	
Arachnoidea		3.1	**2.2**	**7.1**	**1.6**	**1.9**	1.1	3.5	**6.0**	**2.7**	**6.4**
Hydroptilidae		0.03	0.8	**1.8**	0.9	0.6	0.1		0.1	0.7	
Ceratopogonidae		1.4	2.1	1.0	**2.5**	1.7	0.4	2.7	2.8	1.9	0.1
Pisidiidae		1.0	1.5	1.0	1.1	**1.9**	0.6	0.4	2.2	0.8	1.1
Coenagrionidae		2.8	1.9	1.5	1.0	1.5	2.0	2.3	1.8	1.9	**3.4**
Hydrobiidae		0.3		0.8		0.3	0.6	**4.1**	2.8	1.7	2.2
Planorbidae		0.6	0.3	1.0	0.4	0.8	**1.8**	2.1	2.5	**2.4**	**5.7**
Percent Dominant Taxa											
Hyalella azteca	7.9	4.4	**20.6**	**39.3**	**42.0**	**26.5**	**9.8**	**15.6**	**25.8**	**17.8**	
Caenis latipennis	7.6	**4.9**	1.1	1.6	0.5	**19.4**	**26.7**	**23.8**	**10.1**	**54.3**	**38.6**
Tanytarsus	6.7	**4.0**	**13.0**	5.6	**8.3**	**8.5**	**6.9**	3.1	**3.6**	1.4	**1.1**
Stenacron	7.1	**7.9**	0.2	1.2	0.2	1.8	1.1		0.1		2.1
Dicrotendipes	7.9	**6.1**	**9.4**	**4.5**	**15.2**	**5.3**	**7.8**	3.7	**3.6**	**3.3**	**7.9**
Glyptotendipes	8.5	**7.6**	**7.6**	0.8	0.1	0.6	3.6	**5.9**	**15.3**	**3.4**	**11.3**
Tubificidae	9.2	**7.1**	**10.1**	**8.1**	2.6	**5.9**	**12.0**	**7.1**	1.7	0.3	0.7
Acarina	5.7	3.1	2.2	**7.1**	1.6	1.9	1.1	3.5	**6.0**	**2.7**	**6.4**
Procladius	9.3	3.2	1.2	3.4	**4.8**	1.6	0.4	0.4	1.3	0.4	0.2
Ablabesmyia	6.4	1.2	6.0	3.4	**4.0**	1.9	1.8	0.6	1.2	0.6	0.2
Hydrobiidae	8.0	0.3		0.8		0.3	0.6	**4.1**	2.8	1.7	2.2
Helisoma	6.5	0.02		0.1	0.4	0.3	0.4	0.9	1.7	0.8	**3.7**

<u>Spring 2013 Sampling Season</u>

The NFSR GP samples had a high abundance of tolerant organisms, with most taxa having BI values >4.9 (Figure 6 and Table 8). Macroinvertebrates in the very tolerant range (BI >8.9) tended to be variable for the NFSR samples, with some stations having lower values and other stations having higher values than reference conditions for the Central Plains/Osage/South Grand EDU. The only exception was NFSR #6, which had a much higher percentage of the sample made of very tolerant taxa (55 percent) compared to reference conditions. Macroinvertebrates in the tolerant range (BI 7.5 - 8.9) were more abundant at all of the test stations than reference conditions. The percentage for this BI range was especially high compared to reference conditions at test stations #7 - #8.5; with values ranging from about 45 to 53 percent compared to18 percent for the Central Plains/Osage/South Grand EDU. All of the NFSR stations except test station #1 had much lower percentages of moderately tolerant taxa (BI 5.0-7.4) than reference conditions. Macroinvertebrates in the intolerant range (BI 2.5-4.9) were less abundant than references at all NFSR stations, with the value at NFSR #5 being especially low (0.3 percent) compared to reference conditions. With the exception of NFSR #5 and #9.5, which were similar to reference samples, macroinvertebrates in the very intolerant range (BI<2.5) tended to be much less abundant among NFSR stations.

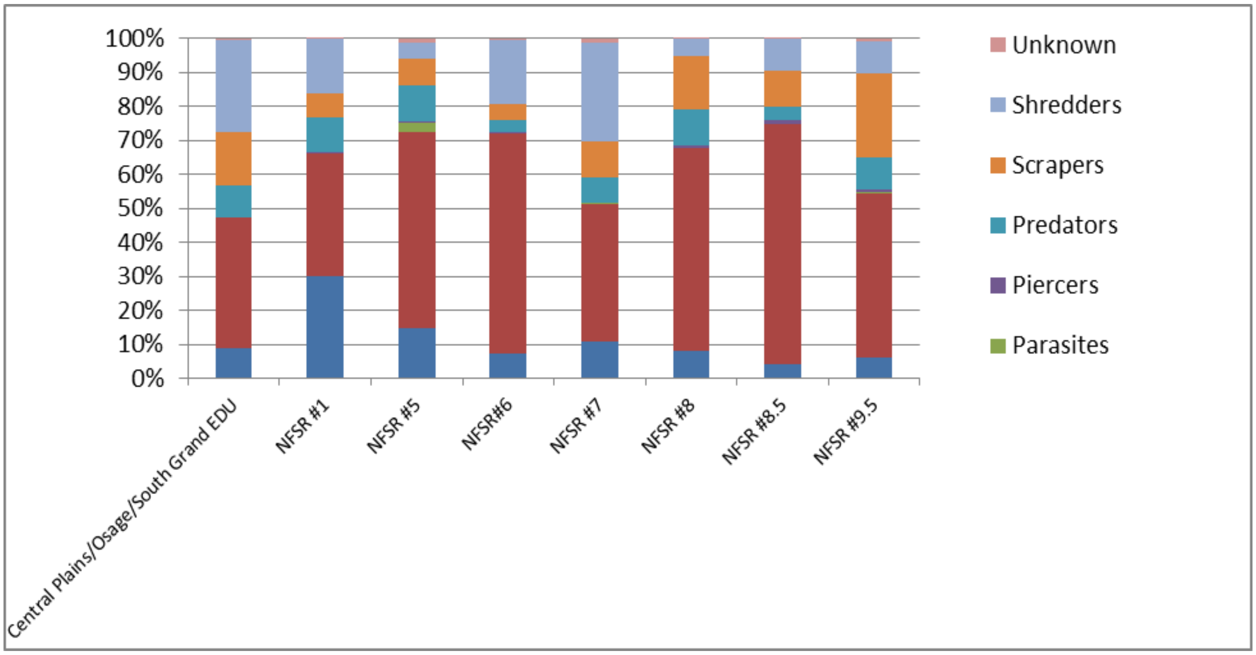
Figure 6

Percent of Taxa by Biotic Index Range for the NFSR and the Central Plains/Osage/South Grand EDU Biological Reference Streams, Spring 2013



Gatherer-collectors were the most abundant FFG at the NFSR GP stations in spring 2013, ranging from about 36 percent at NFSR #1 to about 70 percent at NFSR #8.5 (Figure 7 and Table 8). Most NFSR stations had higher gatherer-collector abundance than the Central Plains/Osage/South Grand EDU reference streams. Gatherer-collector values were similar to reference conditions at NFSR #1 and NFSR #7. Filterers were more abundant than reference

Figure 7
Percent of Taxa by Functional Feeding Group for the NFSR and the Central Plains/Osage/South Grand EDU Biological Reference Streams, Spring 2013



conditions at NFSR #1, #5, and #7. The percentage of filterers was similar to reference conditions at the remaining NFSR sampling stations. Scrapers were lower in abundance among NFSR sampling stations compared to reference conditions with the exception of NFSR #8 and #9.5, which had a higher percentage of scrapers. The percentage of shredders among NFSR stations varied compared to reference conditions. Predators were fairly abundant at most of the NFSR stations, ranging from 3.6 to 10.8 percent. Compared to reference conditions, predators were less abundant at three stations (NFSR #6, #7, #8.5) but similar for the remaining sites.

With the exception of test stations #1 and #7, the NFSR had higher percent EPTT and percent Ephemeroptera in spring 2013 compared to the Central Plains/Osage/South Grand EDU reference samples. These results were caused primarily by the mayfly *Caenis latipennis*, which was the only EPTT that was abundant in any of the NFSR samples. There were no stoneflies found in the NFSR samples, and caddisflies were generally found in low abundance compared to reference conditions.

Chironomidae were common in the NFSR stations, ranging from about 17 to 67 percent of the samples, but most of the test stations had lower chironomid abundances compared to the reference sites (Table 9). Chironomids were very abundant at test stations #1 and #7, making up over 60 percent of the samples compared to less than 30 percent for the other test stations. Three chironomids, *Dicrotendipes*, *Polypedilum illinoense* group, and *Tanytarsus* were abundant at test stations #1 and #7. The chironomid *Glyptotendipes* was also very abundant at test station #7,

Table 8
Sensitive Taxa and FFG at the Glide/Pool NFSR Test Stations, and the Central Plains/Osage/South Grand EDU Biological Criteria Reference Samples, Spring 2013

Variable-Station	CP/O/SG EDU Biocriteria Reference Streams	NFSR #1	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Sample Number		131916	131914	131917	131918	131919	131920	131921
Sensitive Taxa								
% Biotic Index >9.0	27.2	28.1	39.0	55.0	26.1	21.4	28.6	35.1
% Biotic Index 7.5-9.0	18.4	21.8	31.8	29.2	45.4	53.1	53.3	37.7
% Biotic Index 5.0-7.5	43.5	46.8	27.4	11.3	22.5	22.0	14.0	20.1
% Biotic Index 2.5-5.0	8.7	2.6	0.3	4.0	5.1	3.0	3.1	4.3
% Biotic Index <2.5	2.2	0.7	1.5	0.4	1.0	0.5	1.0	2.8
FFG Metrics								
% Filterers	8.8	30.2	14.9	7.3	10.8	8.0	4.2	6.0
% Gatherer-Collectors	38.4	36.0	57.6	64.9	40.6	59.7	70.7	48.6
% Parasites	0.02		2.8		0.2		0.1	0.2
% Piercers	0.1	0.4	0.3	0.4	0.2	0.8	0.9	0.7
% Predators	9.3	10.3	10.8	3.6	7.3	10.5	4.0	9.5
% Scrapers	15.9	6.8	7.7	4.4	10.5	15.9	10.8	24.8
% Shredders	27.1	16.1	4.6	19.0	29.3	5.0	9.2	9.2
% Unknown	0.4	0.2	1.2	0.8	1.1	0.1	0.1	1.0

making up about 16 percent of the sample. Chironomids that were common in some of the other NFSR samples included *Cricotopus/Orthocladius* group at test station #9.5, *Hydrobaenus* at NFSR #8.5 and #9.5, *Tanytarsus* at test station #8, *Polypedilum illinoense* group at test stations #5 and #6, and *Dicrotendipes* at test station #8.5. By comparison, the chironomids, *Cricotopus/Orthocladius* group and *Hydrobaenus* were very common in the reference samples for the Central Plains/Osage/South Grand EDU. Tubificid worms were abundant in all of the NFSR samples. With the exception of stations #7 and #8, tubificid worms were higher in abundance among NFSR sites than the references. Tubificid worms were much more abundant at test station #5 (29 percent) and #6 (39 percent) than the other test stations (<20 percent) and the reference sites (ten percent). Two other taxa that were commonly more abundant among test stations than reference sites were the amphipod *Hyalella azteca* and the caenid mayfly *Caenis latipennis*. *Hyalella azteca* was one of the most abundant taxa at most of the test stations, ranging from about one percent of the sample at NFSR #9.5 to about 24 percent at NFSR #8. *Caenis latipennis* was very abundant in all of the samples except at test stations #1 and #7. Other taxa that were common in one or more of the NFSR samples were the asellid *Lirceus*, enchytraeid worms, pisidiid clams, hydrobiid snails, planorbid snails, and the physid snail *Physella*. *Lirceus* and the black fly *Simulium* were generally not common in the NFSR test stations, but they were abundant in the Central Plains/Osage/South Grand EDU biological criteria reference streams.

Table 9
Percent EPTT, Dominant Macroinvertebrate Families, and Taxa at the Glide/Pool NFSR Test Stations, and the Central Plains/Osage/South Grand EDU Biological Criteria Reference Samples, Spring 2013

Variable-Station	Biotic Index	CP/O/SG Reference Streams	NFSR #1	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Sample Number			131916	131914	131917	131918	131919	131920	131921
EPTT Metrics (%)									
EPTT		10.3	2.2	11.0	16.9	3.3	14.9	25.2	21.7
Ephemeroptera		7.9	1.7	10.7	16.5	3.2	13.9	24.3	20.0
Plecoptera		1.3							
Trichoptera		1.1	0.4	0.3	0.4	0.1	1.0	0.9	1.7
Percent Dominant Families									
Chironomidae		**54.4**	**63.2**	**16.7**	**27.6**	**67.0**	**25.5**	**28.2**	**28.7**
Tubificidae		**10.3**	**13.4**	**28.9**	**38.5**	**7.9**	**9.0**	**19.0**	**16.2**
Asellidae		**6.6**					0.8	0.3	
Simuliidae		**5.0**	1.0		3.4	1.8	0.3	0.9	0.6
Caenidae		**3.2**	1.5	**10.3**	**16.5**	**3.1**	**13.9**	**24.2**	**20.1**
Hyalellidae		2.3	**4.4**	**3.9**	**3.8**	**7.8**	**23.7**	**14.1**	0.7
Enchytraeidae		1.0	**3.5**	2.6	**4.2**	1.7	2.0	0.7	2.0
Pisidiidae		0.4	**2.3**	**14.8**	1.8	1.0	2.2	0.9	3.4
Hydrobiidae		0.3	1.7	2.7		**2.0**	**5.1**	0.8	1.0
Planorbidae		0.1	0.3	0.1	0.2	1.9	2.9	**4.1**	**10.0**
Physidae		1.5	0.6	3.4	1.0	0.2	3.5	0.5	**6.3**
Percent Dominant Taxa									
Cricotopus/Orthocladius grp.	6.5	**21.8**	1.7	0.1	1.6	2.6	0.4	4.2	**4.7**
Hydrobaenus	9.6	**10.9**	2.2		3.2	5.1	3.7	**4.9**	**6.5**
Lirceus	7.7	**6.6**					0.8	0.3	
Tubificidae	9.2	**6.0**	**11.8**	**20.3**	**31.3**	3.1	**8.1**	**18.6**	**14.1**
Simulium	4.4	**4.9**	1.0		3.4	1.8	0.3	0.9	0.6
Tanytarsus	6.7	1.4	**26.9**	1.0	2.0	**8.1**	**5.5**	2.3	2.0
Polypedilum illinoense grp.	9.2	2.5	**6.8**	**6.9**	**7.9**	**8.4**	1.8	1.4	1.7
Dicrotendipes	7.9	1.3	**5.8**	3.9	0.2	**12.1**	3.3	**4.9**	1.2
Hyalella Azteca	7.9	2.3	**4.4**	**14.8**	3.8	**7.8**	**23.8**	**14.1**	0.7
Pisidiidae	7.3	0.4	2.3	**10.3**	1.8	1.0	2.2	0.9	3.4
Caenis latipennis	7.6	2.0	1.5	**6.5**	**16.5**	3.1	**13.9**	**24.2**	**20.1**
Limnodrilus hoffmeisteri	9.8	2.5	0.7	2.6	**5.7**	1.0	0.9		2.1
Enchytraeidae	10.0	1.0	3.5	1.2	**4.2**	1.7	2.0	0.7	2.0
Glyptotendipes	8.5	1.2	0.4	2.7	3.4	**16.4**	0.5	1.8	0.7
Hydrobiidae	8.0	0.3	1.7			2.0	**5.1**	0.8	1.0
Physella	9.1	1.5	0.6	3.4	1.0	0.2	3.5	0.5	**6.3**

3.2 Physiochemical Data

Water samples and field measurements were collected during the fall 2012 and spring 2013 macroinvertebrate sampling periods. Dissolved oxygen data also were collected by ESP WQMS staff at four sampling stations during the summer and early fall of 2012, and the results are included in this section of the report. Physicochemical results are arranged to demonstrate trends of certain variables that may identify a source of effects at the NFSR test stations and the biological criteria reference stations. These results can be found in Table 10 for fall 2012 and Table 11 for spring 2013. The summer/fall 2012 WQMS dissolved oxygen sampling results are presented in Table 12. Results discussed here are for discharge, dissolved oxygen, turbidity, nitrate + nitrite-N, total nitrogen, and total phosphorus by season.

3.2.1 Discharge

Water levels were low at many of the NFSR stations during the fall 2012 sampling season. Discharge ranged from <0.1 cfs at NFSR #9.5 to 14.9 cfs at NFSR #1.

Discharge was much higher during the spring 2013 sampling season, ranging from 20.0 cfs at NFSR #9.5 to 258.9 cfs at NFSR #1. Discharge was not measured at NFSR #5 because of high water levels.

3.2.2 Dissolved Oxygen

Dissolved oxygen ranged from 3.94 mg/L at NFSR #3 to 8.13 mg/L at NFSR #7 in fall 2012. Dissolved oxygen was below the 5 mg/L water quality standard (MDNR 2014) at one NFSR station, and four stations had concentrations between 5 and 6 mg/L during the fall 2012 sampling season.

Many of the dissolved oxygen readings collected by ESP WQMS staff at four NFSR sampling stations during the summer and early fall of 2012 were below minimum WQS (Table 12). Seven of the 11 samples collected at the Highway 160 sampling station, between NFSR #9.5 and #8.5, were below the minimum water quality standard. Most of the water quality violations at this station occurred from May 31 to September 13, 2012. Two of the three dissolved oxygen measurements taken at NFSR #4.5 were below the WQS. The SW 60th Road sampling station, located between NFSR #4.5 and #3, had 10 of 12 dissolved oxygen measurements below WQS. Dissolved oxygen levels were consistently low at this station from early May to late September. At NFSR #1, five of 12 dissolved oxygen measurements were below WQS, with most of the low values occurring from July 24 to September 13, 2012.

Dissolved oxygen was above the 5 mg/L water quality standard of at all sampling stations during the spring 2013 season. Dissolved oxygen ranged from 7.17 mg/L at NFSR #5 to 9.20 mg/L at NFSR #9.5.

3.2.3 Turbidity

During the fall 2012 sampling season, turbidity was above the recommended reference condition values for the Level III Central Irregular Plains or Ozark Highland ecoregions (USEPA 2000a, 2000b) at all of the NFSR test stations except stations #4.5 and #6.

Table 10
Physicochemical Variables at the NFSR Sampling Stations, Fall 2012

	NFSR #1	NFSR #2	NFSR #3	NFSR #4.5	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Physicochemical Sample Number	1204446	1204443	1204444	1204448	1204447	1202922	1204442	1204441	1204445	1202921
Macroinvertebrate Sample Number	120107	120104	120105	120109	120108	120114	120103	120102	120106	120113
Sample Date	09/26/12	09/25/12	09/28/12	09/27/12	09/27/12	10/10/12	09/25/12	09/25/12	09/26/12	10/10/12
Sample Time	1520	1515	1100	1100	0900	1135	1310	1055	1100	1000
Ammonia	0.10	0.12	0.15	0.17	0.30	0.08	0.08	0.11	0.14	0.07
Chloride	13.1	12.3	11.7	17.7	26.5	6.15	7.42	11.1	8.67	11.0
Sulfate	26.3	25.7	18.4	20.9	27.3	17.7	12.5	20.0	15.2	10.8
Total Recoverable Calcium	27.9	24.8	20.0	23.2	26.3	20.6	24.8	28.1	24.1	44.8
Total Recoverable Magnesium	3.53	3.70	3.28	3.67	4.50	3.01	2.89	3.26	2.81	3.64
Total Recoverable Hardness as $CaCO_3$	84.2	77.2	63.4	73.0	84.2	63.8	73.8	83.6	71.7	127
Dissolved Oxygen	6.86	5.93	5.40	7.5	**3.94**	7.73	8.13	5.96	5.04	7.33
Discharge (cfs)	14.9	10.6	8.9	7.1	7.6	0.1	3.2	3.0	0.8	<.1*
pH (Units)	7.2	6.8	7.5	7.5	7.5	8.1	7.6	7.3	7.4	7.7
Conductivity (µS/cm)	232	220	186	235	296	176	184	216	179	290
Temperature (°C)	20.0	21	20.0	20.0	20.0	12	20.0	18.0	19.0	12.0
Turbidity (NTU)	**17.0**	**19.7**	**15.7**	13.7	**16.9**	13.0	**16.6**	**16.7**	**25.6**	**2.57**
NFR	<5*	7.0	7.0	8.0	13.0	<5*	8.0	<5*	12.0.	<5*
Nitrate + Nitrite	**1.02**	**0.83**	**0.68**	**0.79**	**0.88**	0.06	**0.69**	**0.78**	**0.72**	0.05
Total Nitrogen	**1.70**	**1.66**	**1.45**	**1.73**	**2.54**	0.60	**1.63**	**1.53**	**1.59**	**0.50**
Total Phosphorus	**0.06**	**0.11**	0.06	**0.14**	**0.32**	0.09	0.05	**0.10**	**0.19**	**0.06**

*Below detectable limits
Units mg/L unless otherwise noted. Values in bold are elevated compared to the Missouri Water Quality Standards or USEPA recommended reference condition values.

Table 11
Physicochemical Variables at the NFSR Sampling Stations, Spring 2013

	NFSR #1	NFSR #5	NFSR #6	NFSR #7	NFSR #8	NFSR #8.5	NFSR #9.5
Physicochemical Sample Number	131803	131727	131726	131725	131802	131801	131800
Macroinvertebrate Sample Number	131916	131914	131917	131918	131919	131920	131921
Sample Date	04/16/2013	05/02/2013	04/16/2013	04/16/2013	04/16/2013	04/16/2013	04/16/2013
Sample Time	0900	1140	1355	1105	1510	1245	1050
Ammonia	0.25	0.23	0.34	0.22	0.13	0.12	0.12
Chloride	13.6	11.7	12.7	14.2	14.9	15.8	15.1
Sulfate	39.2	27.3	43.5	28.7	26.8	25.3	20.6
Total Recoverable Calcium	38.2	33.4	34.4	41.5	44.6	45.2	57.3
Total Recoverable Magnesium	4.46	4.26	4.85	4.19	4.26	3.95	4.89
Total Recoverable Hardness as $CaCO_3$	114	101	106	121	129	129	163
Dissolved Oxygen	8.76	7.17	8.96	9.13	9.98	8.85	9.20
Discharge (cfs)	258.9	N/A	86.7	39.5	40.6	27.5	20.0
pH (Units)	7.9	7.8	7.8	7.9	7.9	7.8	7.6
Conductivity (µS/cm)	282	245	259	273	286	292	282
Temperature (°C)	13.3	18.0	12.5	14.2	13.5	13.5	13.9
Turbidity (NTU)	**13.1**	13.3	**28.0**	12.3	6.71	**6.57**	**5.13**
NFR	15.0	17.0	46.0	18.0	11.0	7.00	5.00
Nitrate + Nitrite	**1.90**	**1.16**	**1.60**	**2.41***	**2.59***	**2.64***	**2.91***
Total Nitrogen	**2.81**	**1.87**	**2.92**	**3.41**	**3.06**	**3.37**	**3.64**
Total Phosphorus	**0.13**	**0.16**	**0.23**	**0.13**	0.08	**0.09**	**0.07**

*Sample diluted during analysis
Units mg/L unless otherwise noted. Values in bold are elevated compared to the Missouri Water Quality Standards or USEPA recommended reference condition values.

Table 12
Dissolved Oxygen and Discharge Field Measurements Collected by ESP WQMS staff, May-September, 2012

Date	Station	Time	Dissolved Oxygen (mg/L)	Discharge (cfs)
05/03/2012	Highway 160	1000	6.42	125
05/03/2012	SW 60th Road	0830	**3.86**	985
05/03/2012	NFSR #1	0815	**4.38**	7480*
05/16/2012	NFSR #4.5	1345	5.40	20.6
05/16/2013	SW 60th Road	1420	4.50	
05/17/2012	SW 60th Road	0940	**4.81**	
05/16/2012	Highway 160	1140		6.9
05/17/2012	Highway 160	1030	5.40	
05/16/2012	NFSR #1	1500	7.32	8.8
05/17/2012	NFSR #1	0915	6.04	
05/30/2012	Highway 160	1215	**4.77**	11.1
05/31/2012	Highway 160	1020	6.55	
05/30/2012	NFSR #4.5	1405	**4.51**	4.3
05/30/2012	SW 60th Road	1440	7.40	
05/31/2012	SW 60th Road	0935	**2.65**	
05/30/2012	NFSR #1	1510	6.81	31.0
05/31/2013	NFSR #1	0915	5.73	129
07/03/2013	Highway 160	1200		0.1
07/04/2012	Highway 160	0930	**4.00**	
07/03/2012	NFSR #4.5	1300		1.6
07/04/2012	SW 60th Road	0900	**3.54**	
07/04/2012	NFSR#1	0830	**4.93**	8.4
07/23/2012	Highway 160	1100		0
07/24/2012	Highway 160	0930	**1.66**	
07/23/2012	NFSR #4.5	0945		0.1
07/24/2012	SW 60th Road	0855	**4.76**	
07/24/2012	NFSR #1	0845	**2.23**	3.7
08/15/2012	Highway 160	1050	**2.70**	0
08/16/2012	Highway 160	0945	**2.90**	
08/15/2012	NFSR #4.5	1135	**4.00**	0.1
08/15/2012	SW 60th Road	1215	**2.50**	
08/16/2012	SW 60th Road	0900	6.50	
08/15/2012	NFSR #1	1315	7.30	0.01
08/16/2012	NFSR #1	0830		3.7
08/27/2012	SW 60th Road	0856	**3.04**	
08/28/2012	NFSR#4.5	1405		8.8
08/28/2012	NFSR #1	1155		36.2
08/28/2012	NFSR #1	1320	6.49	
09/12/2012	Highway 160	1204		0.2
09/13/2012	Highway 160	0929	**3.72**	
09/12/2012	NFSR #4.5	1356		1.2
09/13/2012	SW 60th Road	0855	**1.79**	
09/12/2012	NFSR #1	1500		1.20
09/13/2012	NFSR #1	0826	**3.38**	
09/26/2012	Highway 160	1135		0.8
09/27/2012	Highway 160	0935	5.41	
09/26/2012	NFSR #4.5	1322		7.1
09/27/2012	SW 60th Road	0856	**3.04**	
09/26/2012	NFSR #1	1445		14.9
09/27/2012	NFSR #1	0825	5.59	

*Discharge measurement was based on the value collected at USGS gauging station 07185910 located near Purcell, Missouri.
Values in bold are below the 5 mg/L minimum dissolved oxygen Missouri Water Quality Standard.

The USEPA recommended reference condition for turbidity is 15.5 NTU in the Central Irregular Plains Ecoregion and 1.43 NTU for the Ozark Highlands Ecoregion. Turbidity ranged from 2.57 NTU at NFSR #9.5 to 25.6 NTU at NFSR #8.5.

Turbidity was elevated at four of the seven sampling stations compared to the USEPA recommended reference condition during the spring 2013 sampling season. Turbidity ranged from 5.13 NTU at NFSR #9.5 to 28.0 NTU at NFSR #6.

3.2.4 Nitrate + Nitrite-N

With the exception of stations #6 and #9.5, nitrate + nitrite-N was higher at all of the NFSR sites than EPA's recommended reference condition values for the Level III Central Irregular Plains or Ozark Highlands ecoregions (USEPA 2000a, 200b) during the fall 2012 sampling season. However, test stations #6 and #9.5 were sampled about two weeks later than the other stations, which could explain these lower values. The USEPA recommended reference condition values for nitrate + nitrite-N is 0.23 mg/L in the Central Irregular Plains Ecoregion and 0.24 mg/L for the Ozark Highlands Ecoregion. Nitrate + nitrite-N ranged from 0.05 mg/L at NFSR #9.5 to 1.02 mg/L at NFSR #1.

Nitrate+nitrite-N was higher than USEPA recommended concentrations at all NFSR stations in spring 2013. Nitrate + nitrite-N ranged from 1.16 mg/L at NFSR #5 to 2.91 mg/L at NFSR #9.5.

3.2.5 Total Nitrogen

With the exception of station #6, total nitrogen was higher than USEPA recommended concentrations at all NFSR stations in fall 2012. The USEPA recommended reference condition value for total nitrogen is 0.71 mg/L in the Central Irregular Plains Ecoregion and 0.38 mg/L for the Ozark Highlands Ecoregion. Total nitrogen ranged from 0.50 mg/L at NFSR #9.5 to 2.54 mg/L at NFSR #5.

All of the NFSR sampling stations had elevated total nitrogen concentrations compared to USEPA recommended reference conditions during the spring 2013 sampling season. Total nitrogen ranged from 1.87 mg/L at NFSR #5 to 3.64 mg/L at NFSR #9.5.

3.2.6 Total Phosphorus

Total phosphorus was higher at most NFSR test stations compared to the recommended USEPA total phosphorus reference condition values. The USEPA recommended concentration for total phosphorus is 0.09 mg/L in the Central Irregular Plains Ecoregion and 0.006 mg/L for the Ozark Highlands Ecoregion. Total phosphorus ranged from 0.05 mg/L at NFSR #7 to 0.32 mg/L at NFSR #5.

All of the NFSR sampling stations except station #8 had higher total phosphorus concentrations than USEPA recommended reference conditions during the spring 2013 sampling season. Total phosphorus ranged from 0.08 mg/L at NFSR #8 to 0.23 mg/L at NFSR #6.

4.0 Data Trends
4.1 Macroinvertebrate Biological Assessment
4.1.1 MSCI and Biological Metrics

<u>Fall Sampling Season</u>

The RP MSCI scores at NFSR #1 during the fall 2006 and 2012 sampling seasons were 16 during both sampling years (Table 13). There were some small differences in biological metric values at NFSR #1 among fall sampling seasons, which included higher values for TR, BI, and SDI during the fall 2006 sampling season and a higher value for EPTT during the fall 2012 sampling season.

Most of the GP stations sampled in 2012 had the same or higher MSCI scores compared to 2006 (Table 14). The only exceptions were at NFSR #7 and the nearby sampling stations NFSR #8.5 (2012) and NFSR #9 (2006). In 2006 NFSR #7 had a fully supporting MSCI score of 18 compared to a fully supporting score of 16 in 2012. NFSR #9 had a fully supporting score of 16 in 2006 but a partially supporting score of 14 at NFSR #8.5 in 2012. MSCI scores were the same during both years at NFSR #1 (RP criteria), NFSR #3, #6, and #8. Higher MSCI scores occurred in 2012 than 2006 at NFSR #1 (GP criteria), #2, #4.5 (compared to NFSR #4 in 2006), #5, and #9.5 (compared to NFSR #10 in 2006). Three of the stations or nearby stations changed from partially supporting MSCI scores in 2006 to fully supporting MSCI scores in 2012. Duplicate samples at NFSR #4 had partially supporting scores of 12 and 14 in 2006 but a fully supporting MSCI score of 16 at the nearby NFSR #4.5 in 2012. The primary difference in MSCI scores at NFSR #4 and #4.5 was a higher EPTT and lower BI value at NFSR #4.5 during the 2012 sampling season. At NFSR #5, the MSCI score increased from the partially supporting score of 14 in 2006 to a fully supporting score of 16 in 2012. The higher MSCI score at NFSR #5 in 2012 resulted from a higher EPTT value. The MSCI score at NFSR #10 was partially supporting (12) in 2006 compared to a partially supporting score of 14 at the nearby station NFSR #9.5 in 2012. The difference in MSCI scores between the two stations was that NFSR #9.5 in 2012 had higher EPTT and lower BI values than NFSR #10 in 2006.

Among GP samples, EPTT, and BI generally showed improvement among NFSR stations during the fall 2012 sampling season (Table 14). BI was lower at all stations in 2012 compared to 2006, ranging from 7.4 to 7.8 in fall 2012, compared to 7.8 to 8.6 in 2006. The number of EPTT was higher at seven of the ten stations in 2012 compared to 2006. The number of EPTT ranged from three to 11 in 2012 compared to one to eight in 2006. The remaining biological metrics, TR, and SDI, generally performed better in 2006 than 2012, however. SDI was higher at eight of the ten sampling stations in 2006, ranging from 2.58 to 3.36 compared to 1.89 to 2.98 in 2012. All sampling stations upstream of Lamar had higher TR values in the fall 2006 samples. Downstream of Lamar, the only station that a higher TR value in 2006 was NFSR #2. Values for TR ranged from 53 to 88 in 2006 compared to 55 to71 in 2012.

Table 13
Riffle/Pool Ozark/Osage EDU Transitional Stream Biological Criteria, Biological Support Categories, and MSCI Scores for the NFSR Sampling Stations

Station	Sample Year	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
Fall Sampling Season								
NFSR #1	2006	0602717	81	**9**	**7.5**	3.20	16	F
	2012	120107	80	13	**7.0**	**3.13**	16	F
Metric Score=5	If		>77	>12	<6.9	>3.13	20-16	**F**ull
Metric Score=3	If		77-39	11-6	6.9-8.5	3.14-1.57	14-10	**P**artial
Metric Score=1	If		<39	<6	>8.5	<1.57	8-4	**N**on
Spring Sampling Season								
NFSR #1	2007	0703244	**72**	**9**	**7.58**	**3.28**	12	P
Metric Score=5	If		>77	>17	>6.4	>3.31	20-16	**F**ull
Metric Score=3	If		77-39	17-8	6.4-8.2	3.31-1.65	14-10	**P**artial
Metric Score=1	If		<39	<8	>8.2	<1.65	8-4	**N**on

MSCI Scoring Table (in light gray) developed from transitional Ozark/Osage EDU BIOREF streams (n=5 for each sampling period); TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index. Values in bold were sub-optimal compared to biological criteria.

Table 14
Glide/Pool Central Plains/Osage/South Grand EDU Stream Biological Criteria, Biological Support Categories, and MSCI Scores for the NFSR Sampling Stations for the Fall Sampling Season

Station	**Sample Year**	**Sample Number**	**TR**	**EPTT**	**BI**	**SDI**	**MSCI**	**Support**
NFSR #1	2006	0602717	71	7	**7.8**	3.11	18	F
	2012	120107	71	11	7.4	2.87	20	F
NFSR #2	2006	0602718	68	**6**	**8.2**	2.88	16	F
	2012	120104	64	7	7.5	2.98	20	F
NFSR #3	2006	0602719	57	8	**7.9**	**2.78**	16	F
	2012	120105	63	7	**7.7**	**2.67**	16	F
NFSR #4	2006	0602720	**53**	**2**	**8.3**	2.90	12	**P**
	2006	0602722	57	**3**	**8.3**	**2.78**	14	**P**
NFSR #4.5	2012	120109	63	8	**7.6**	**2.39**	16	F
NFSR #5	2006	0602721	61	**3**	**8.6**	**2.58**	14	**P**
	2012	120108	61	8	**7.7**	**2.79**	16	F
NFSR #6	2006	0602723	74	**6**	**8.0**	3.36	16	F
	2012	120114	63	7	**7.8**	**2.81**	16	F
NFSR #7	2006	0602724	88	8	**8.0**	3.26	18	F
	2012	120103	69	**5**	**7.7**	2.98	16	F
NFSR #8	2006	0602725	67	**4**	**8.5**	2.94	16	F
	2012	120102	61	**5**	**7.6**	2.86	16	F
NFSR #8.5	2012	120106	**55**	7	**7.6**	**1.89**	14	P
NFSR #9	2006	0602726	63	**4**	**8.3**	3.11	16	F
NFSR #9.5	2012	120113	60	**3**	**7.6**	**2.52**	14	P
NFSR #10	2006	0602727	66	**1**	**8.6**	**2.85**	12	P
Metric Score=5	If		>55	>6	<7.6	>2.85	20-16	**F**ull
Metric Score=3	If		55-28	6-3	7.7-8.9	2.87-1.43	14-10	**P**artial
Metric Score=1	If		<28	<3	>8.9	<1.43	8-4	**N**on

MSCI Scoring Table (in light gray) developed from Central Plains/Osage/South Grand EDU BIOREF streams (n=15); TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index. Values in bold were sub-optimal compared to biological criteria.

Spring Sampling Season

A RP sample from NFSR #1 was not collected during the spring 2013 sampling season because of high stream flows. During the spring 2007 sampling season, NFSR #1 had a partially supporting RP MSCI score of 12.

A comparison of 2007 and 2013 GP MSCI scores showed few consistent trends (Table 15). NFSR #5, NFSR #7, and duplicate sample #0703247 from NFSR #9 in 2007 (compared to NFSR #8.5 in 2013) had the same MSCI scores between sample years. The other duplicate sample (#0703248) at NFSR #9 in 2007 had a much lower score than nearby station NFSR #8.5 (2013). The spring 2013 NFSR #1 and NFSR #6 MSCI scores were lower than 2007, but NFSR #8 and NFSR #9.5 were higher (compared to NFSR #10 in 2007). The 2007 MSCI scores ranged from ten to 16, with four of 11 samples having scores in the partially supporting range. In 2013, MSCI scores ranged from 12 to 16, with four of seven samples having scores in the partially supporting range. Stations #1 and #6 changed from fully supporting MSCI scores in 2007 to partially supporting in 2013, and station #8 changed from partially supporting in 2007 to fully supporting in 2013. The MSCI score at NFSR #1 dropped from 16 in 2007 to 14 in 2013, and the MSCI score at NFSR #6 dropped from 16 in 2007 to 12 in 2013. At NFSR #8, the MSCI score increased from 14 in 2007 to 16 in 2013. The difference in spring 2013 MSCI scores resulted from a lower EPTT value at NFSR #1, lower TR and EPTT values at NFSR #6, and a higher EPTT value at NFSR #8.

Two of the biological metrics, EPTT, and BI, were higher at more stations in the spring of 2007 than 2013 (Table 15). BI was higher at four of the seven stations in 2007 compared to 2013, ranging from 7.3 to 8.3 in spring 2007 compared to 7.6 to 8.4 in 2013. The number of EPTT also was higher at four of the seven stations in 2007 compared to 2013. The number of EPTT ranged from one to six in 2007 compared to three or four in 2013. The other two metrics, TR and SDI, generally performed better in spring 2013 than 2007. The SDI metric was higher at four of the seven sampling stations in 2013. Values for SDI ranged from 2.54 to 3.13 in 2013 compared to 2.40 to 3.18 in 2007. TR was higher at four of seven sampling stations in 2013. Values for TR ranged from 38 to 67 in 2013 compared to 43 to 69 in 2007.

4.1.2 Macroinvertebrate Community Composition

Fall Sampling Season

Percent EPTT and Chironomidae at the RP station NFSR #1 were much higher during the fall of 2012 than 2006 (Table 16). The higher percent EPTT value in 2012 resulted from the higher abundance of the mayflies *Caenis latipennis* and *Tricorythodes*. *Tricorythodes* was not found in the 2006 sample but made up about 13 percent of the sample in 2012. Other differences in the dominant taxa between the two sample years was a higher abundance of the chironomid *Tanytarsus* in 2012 and higher abundances of tubificid worms, the chironomid *Polypedilum flavum*, the riffle beetle *Stenelmis*, and Corixidae in 2006. The amphipod *Hyalella azteca* was equally abundant during both sampling years, making up about 12 percent of the samples in 2006 and 2012.

Compared to fall 2006, percent EPTT among GP stations was higher in fall 2012 samples at all stations except NFSR #2 (Table 17). The higher percentage of EPTT in 2012 resulted from a higher percentage of the mayfly *Caenis latipennis*. *Caenis latipennis* was the only EPTT

commonly found in the NFSR during both sampling seasons, and it was particularly abundant in NFSR #5 - #7 and NFSR #8.5 - #9.5 in fall 2012. A higher percentage of Chironomidae was present at eight of ten stations in 2006 compared to 2012. Percent Chironomidae in 2006 ranged from about 25 percent at NFSR #1 to about 60 percent at NFSR #8. In 2013, percent Chironomidae ranged from 12 percent at NFSR #8.5 to 49 percent at NFSR #1 and #2.

Table 15
Glide/Pool Central Plains/Osage/South Grand EDU Stream Biological Criteria, Biological Support Categories, and MSCI Scores for the NFSR Sampling Stations for the Spring Sampling Season

Station	Sample Year	Sample Number	TR	EPTT	BI	SDI	MSCI	Support
NFSR #1	2007	0703244	63	**5**	**8.1**	3.18	16	F
	2013	120107	67	**3**	**7.6**	3.03	14	**P**
NFSR #2	2007	0703253	61	**5**	**8.1**	2.80	16	F
NFSR #3	2007	0703252	60	**6**	**7.5**	2.67	16	F
NFSR #5	2007	0703245	69	**5**	**8.3**	2.94	16	F
	2013	131914	55	**4**	**8.2**	2.95	16	F
NFSR #6	2007	0703246	61	**6**	**7.4**	2.72	16	F
	2013	131917	**38**	**3**	**8.4**	2.54	12	**P**
NFSR #7	2007	0703251	57	**3**	**7.3**	2.76	14	**P**
	2013	131918	62	**3**	**7.9**	3.13	14	**P**
NFSR #8	2007	0703249	58	**2**	**8.3**	2.70	14	**P**
	2013	131919	58	**4**	**7.7**	2.96	16	F
NSR #8.5	2013	131920	58	**4**	**7.9**	2.71	16	F
NFSR #9	2007	0703247	55	**4**	**7.6**	2.59	16	F
	2007	0703248	**50**	**3**	**7.8**	**2.42**	10	**P**
NFSR #9.5	2013	131921	59	**3**	**7.8**	3.00	14	**P**
NFSR #10	2007	0703243	**43**	**1**	**8.1**	**2.40**	10	**P**
Metric Score=5	If		>50	>8	<7.3	>2.53	20-16	**F**ull
Metric Score=3	If		50-25	8-4	7.3-8.7	2.53-1.27	14-10	**P**artial
Metric Score=1	If		<25	<4	>8.7	<1.27	8-4	**N**on

MSCI Scoring Table (in light gray) developed from Central Plains/Osage/South Grand EDU BIOREF streams (n=12); TR=taxa richness; EPTT=Ephemeroptera, Plecoptera, Trichoptera Taxa; BI=Biotic Index; SDI=Shannon Diversity Index. Values in bold were sub-optimal compared to biological criteria.

Table 16
Percent EPTT, Chironomidae, and Dominant Macroinvertebrate Taxa in the Riffle/Pool NFSR Samples during the 2006-2007 and 2012-2013 Studies

Variable-Station	**NFSR #1**		
Sample Year	2006	2012	2007
Sampling Season	Fall	Fall	Spring
EPTT and Chironomidae Metrics			
% EPTT	8.1	25.9	4.6
% Ephemeroptera	7.2	24.1	3.8
% Plecoptera			0.1
% Trichoptera	0.9	1.8	0.7
% Chironomidae	23.3	37.7	60.4
Percent Dominant Taxa			
Tubificidae	**13.3**	4.9	**6.7**
Hyalella azteca	**12.0**	**12.6**	5.3
Polypedilum convictum	**8.8**	2.3	**6.3**
Stenelmis	**8.2**	**5.0**	1.9
Corixidae	**6.7**		0.3
Caenis latipennis	5.7	**8.2**	3.6
Tanytarsus	3.6	**16.1**	**6.8**
Tricorythodes		**12.7**	
Cricotopus/Orthocladius Group	0.3	0.9	**12.8**
Polypedilum scalaenum Group	0.2	2.3	**9.2**

In addition to *Caenis latipennis*, the amphipod *Hyalella azteca* and the chironomids *Tanytarsus* and *Ablabesmyia* generally were more abundant in 2012 than 2006. *Hyalella azteca* was abundant during both sampling years, but it was more abundant in 2012 at all stations except NFSR #9.5. *Tanytarsus* was much more abundant in 2012 at all but the two most upstream stations. *Ablabesmyia* was only abundant at four NFSR stations in 2012, but was generally more abundant than in 2006. Taxa that were generally more abundant in 2006 than 2012 were the chironomid *Glyptotendipes*, the aquatic worm family Tubificidae (including *Quistadrilus multisetosus* and *Branchiura sowerbyi*), and the phantom midge *Chaoborus*. *Glyptotendipes* was one of the most common taxa found in the NFSR in 2006, and it was more abundant than 2012 at all stations except at NFSR #10. Tubificidae was abundant at many of the stations during both sample years, but it was more abundant at more stations in 2006. *Chaoborus* was among the dominant taxa at only two stations in 2006 (NFSR #3 and #5), but it had a higher abundance at most of the stations in 2006 than 2012. *Quistradrilis multisetosus* was only abundant at some of the stations downstream of Lamar in 2006, but it was more abundant at these stations than 2012. *Branchiura sowerbyi* was much more abundant at the four most upstream sampling stations in 2006, but it was relatively rare at the other sampling stations during both sampling years. Several taxa were abundant at only a few stations either in 2006 or 2012 but were not consistently found throughout the sampling reach. Taxa that were locally abundant at only one to three stations in 2006 included Corixidae, the elmid beetle *Dubiraphia*, the tubificid worm

Table 17
Percent EPTT, Chironomidae, and Dominant Macroinvertebrate Taxa at the NFSR Test Stations, Fall 2006 and 2012 Glide/Pool Samples

Variable-Station	**NFSR #1**		**NFSR #2**		**NFSR #3**		**NFSR #4**		**NFSR #4.5**	**NFSR #5**		**NFSR #6**		**NFSR #7**		**NFSR #8**		**NFSR #8.5**	**NFSR #9**	**NFSR #9.5**	**NFSR #10**
Sample Year	2006	2012	2006	2012	2006	2012	2006	2006	2012	2006	2012	2006	2012	2006	2012	2006	2012	2012	2006	2012	2006
EPTT and Chironomidae Metrics																					
% EPTT	4.0	15.8	15.1	5.0	5.6	5.7	2.4	2.4	3.5	1.5	22.8	15.7	28.4	18.4	24.5	7.1	10.9	55.6	9.1	41.8	0.9
% Ephemeroptera	3.8	14.4	15.1	3.9	4.6	3.2	2.3	2.3	2.1	1.5	21.6	15.3	28.2	16.3	24.3	7.0	10.8	54.8	9.1	41.8	0.9
% Trichoptera	0.2	1.4		1.0	1.0	2.5	0.1	0.1	1.4		1.2	0.5	0.2	2.1	0.2	0.1	0.1	0.8			
% Chironomidae	24.6	48.8	50.8	48.8	30.7	25.0	40.5	39.6	40.4	49.3	27.9	37.3	35.8	33.0	29.0	59.6	33.1	12.0	49.6	30.3	40.0
Percent Dominant Taxa																					
Hyalella azteca	**15.8**	**19.8**	**9.7**	**20.6**	**28.5**	**39.3**	**8.8**	**9.4**	**42.0**	**18.7**	**26.5**	**8.3**	**9.8**	4.8	**15.6**		**25.8**	**17.8**	0.1		
Glyptotendipes	**11.2**	1.8	**23.0**	**7.6**	3.0	0.8	**18.9**	**21.9**	0.1	**33.7**	0.6	4.9	3.6	**14.8**	**5.9**	**21.0**	**15.3**	**3.4**	**9.0**	**11.3**	7.8
Tubificidae	**10.9**	1.6	6.1	**10.1**	**5.2**	**8.1**	3.0	**5.6**	2.6	**5.1**	**5.9**	4.4	**12.0**	**8.9**	**7.1**	**5.4**	1.7	0.3	**8.2**	0.7	**20.4**
Corixidae	**9.2**	0.3	1.2	0.4	1.1	0.2	0.2	0.5	0.1	1.0	0.2	0.1	0.1		0.1	0.6	1.4		0.5		0.1
Dubiraphia	**8.1**	1.0	0.6		0.1		0.3	0.3		0.1		5.4	0.2	0.9		0.8			0.7		0.1
Tanytarsus	0.7	**18.5**	**10.1**	**13.0**	2.5	**5.6**	2.4	2.0	**8.3**	**3.9**	**8.5**	2.3	**6.9**	2.7	3.1	0.6	**3.6**	1.4	3.3	1.1	0.7
Caenis latipennis	0.8	**12.3**	**12.3**	1.1	1.1	1.6	2.3	2.2	0.5	1.3	**19.4**	**11.0**	**26.7**	**14.9**	**23.8**	**6.2**	**10.1**	**54.3**	**7.7**	**38.6**	0.9
Dicrotendipes	3.5	**11.4**	**7.2**	**9.4**	**11.2**	**4.5**	4.3	5.1	**15.2**	1.7	**5.3**	**8.4**	**7.8**	**7.3**	3.7	**16.2**	**3.6**	**3.3**	**18.9**	**7.9**	6.6
Ablabesymia	0.5	**3.7**	0.7	6.0	0.9	3.4			**4.0**		1.9	2.3	1.8	0.7	0.6	0.4	1.2	0.6	1.7	0.2	0.2
Chaoborus	0.1		0.6	0.9	**12.6**	0.2	3.3	1.3	0.1	**6.2**	0.2	1.5		2.2	0.1	2.6	0.2		1.5		0.1
Tribelos	2.1	2.0	0.7	0.5	**6.5**	1.6	0.4	0.1	1.0	0.2	1.0	1.5	3.0		0.3	1.2	0.2	0.5	1.4	2.7	
Acarina	3.2	1.5	0.5	2.2	2.3	**7.1**	1.3	2.3	1.6	1.0	1.9	1.2	1.1	1.2	3.5	3.2	**6.0**	**2.7**	2.0	**6.4**	0.5
Aulodrilus	1.9		2.1		2.1	2.1	**10.7**	**17.5**	0.4	1.7	0.1	0.9		0.7		0.1			0.1		
Quistradrilus	4.5	0.5	4.3	0.5	1.0	0.7	**10.2**	5.5	0.7	1.0	0.4	0.2		0.3	1.8						
Scirtidae	1.7		2.1	0.3	1.5		**7.5**	**6.1**		1.9		1.7	0.7	3.4	0.2	1.0		0.1	0.6	1.7	1.2
Procladius	0.4	1.1	1.0	1.2	2.1	3.4	1.7	1.9	**4.8**	**3.9**	1.6	**5.6**	0.4	0.8	0.4	5.1	1.3	0.4	2.8	0.2	0.3
Kiefferulus	0.5		1.2			0.3	2.2	1.6	0.1	0.3		**6.9**	0.1	0.8	0.1	**7.5**	0.9		6.5		**9.1**
Branchiura		0.1			0.2	0.1	0.5	0.5	0.2	0.6		1.8	0.2	**5.5**	0.1	4.6	2.9	0.1	**9.2**	0.2	**10.7**
Goeldichironomus			0.3				0.2	0.2		0.2	0.2	0.3		0.6					0.1		**9.6**
Pisidiidae	0.6		0.2	1.5	0.1	0.9	0.2	0.2	1.1		1.9	2.0	0.6	1.0	0.4	2.1	2.2	0.8	1.1	1.1	**8.0**
Hydrobiidae	0.9	0.5				0.8					0.3	1.3	0.6	0.9	**4.1**	0.2	2.8	1.7		2.2	0.4
Helisoma	0.4					0.1			0.4		0.3		0.4	0.1	0.9	0.1	1.7	0.8	0.5	**3.7**	0.1

Aulodrilus, the beetle Scirtidae, pisidiid clams, and chironomids *Kiefferulus* and *Goeldichironomus*. In 2012, hydrobiid snails were abundant at NFSR #7, and the snail *Helisoma* was abundant at NFSR #9.5.

Spring Sampling Season

A RP sample from NFSR #1 was not collected during the spring 2013 sampling season because of high flows during the sample period; therefore, no comparisons can be made using the 2007 RP data.

With the exception of NFSR #1 and #7, percent EPTT among GP test stations was much higher during the spring of 2013 compared to the spring of 2007 (Table 18). The higher percentage of EPTT in 2013 was caused primarily by a higher percentage of the sample being made up of the mayfly *Caenis latipennis*. *Caenis latipennis* was the only EPTT commonly found in the NFSR during both sampling seasons, and it was very abundant in most spring 2013 NFSR samples. Percent Chironomidae was much higher in 2007 except at NFSR #1 and #7. Chironomid abundance ranged from about 38 percent at NFSR #2 to about 64 percent at NFSR #10, compared to a range of 17 percent at NFSR #5 to 67 percent at NFSR #7 in 2013. Other taxa that were generally more abundant in 2013 than 2007 included the amphipod *Hyalella azteca*, tubificid worms, and the chironomids *Tanytarsus* and *Polypedilum illinoense* group. *Hyalella azteca* was abundant among at least some stations during both sampling years, but it was much more abundant at four of the seven stations in 2013. *Tanytarsus* was more abundant at all stations in 2013, but it was particularly abundant at NFSR stations #1, #7, and #8. *Polypedilum illinoense* group also was more abundant at all NFSR stations in 2013, but it was much more abundant at NFSR #1 and #5 - #7. Tubificid worms were abundant during both sample years, but they were much more numerous at most stations sampled in 2013. Taxa that were generally more abundant at the NFSR stations in 2007 than 2013 were the chironomids *Cricotopus/Orthocladius* group, *Hydrobaenus*, *Procladius*, *Dicrotendipes*, and the snail *Physella*. Compared to 2013, *Cricotopus/Orthocladius* group was more abundant in 2007 at all stations, making up 2.9 to 25.7 percent of samples. By comparison, *Cricotopus/Orthocladius* grp. made up 0.1 to 4.7 percent of samples in 2013. *Hydrobaenus* was much more abundant at most NFSR stations in 2007, especially at the three most upstream stations. *Procladius* tended to be more abundant in 2007 compared to 2013, especially among NFSR #1, #3, #5, and #6, where they were particularly abundant. *Dicrotendipes* was abundant at about half of the sampling stations during both years, but more stations (four of seven) had higher abundances in 2007 than 2013. *Physella* was more abundant at five of the seven stations in 2007, and the highest abundances in 2007 occurred at NFSR #7-#9.5. There were some taxa that were abundant at only a few stations either in 2007 or 2013 but not consistently found throughout the sampling reach. Taxa that were abundant at one to three stations in 2007 or 2013 included Planariidae, dipterans from the Ceratopogoninae subfamily, hydrobiid snails, and the chironomids *Eukiefferiella* and *Glyptotendipes*.

4.1.3 Physicochemical Data

Fall Sampling Season

Dissolved oxygen data showed that some stations had low concentrations in both the fall 2006 and 2012 sample seasons, but there were more water quality violations in 2006 (Table 19). Although 2012 discharge was much higher than 2006 when samples were collected (except at

NFSR #6 and #9.5), these discharge values were due to recent rain events, and were not typical of summer 2012 conditions. About a month before sampling, the NFSR was very low because of extreme drought conditions during the summer months of 2012. Because of the dry conditions, the NFSR #6 and #9.5 sample reaches consisted of isolated pools with very little water. It was decided to delay sampling NFSR #6 and #9.5 to allow macroinvertebrates to colonize these two stream reaches. Rains that occurred between site reconnaissance and the date that discharge was measured resulted in higher discharge values in 2012 at most of the sampling stations. Drought conditions were also present in 2006, which explains the very low discharge values for that sampling season.

Nutrient data from both fall 2006 and 2012 were higher than USEPA recommended reference criteria. Nitrate + nitrite-N concentrations were higher at all stations and total nitrogen concentrations were higher at most stations during the fall 2012 season than the recommended reference criteria. Total phosphorus was higher than most of the samples than recommended reference criteria, but it was not consistently higher in either sampling year.

<u>Spring Sampling Season</u>
Spring 2013 dissolved oxygen concentrations were higher than 2007 at all sampling stations except NFSR #5 (Table 20). Dissolved oxygen ranged from 6.52 to 8.49 mg/L in 2007 and 7.17 to 9.98 mg/L in 2013. Discharge was higher in 2013 than 2007, ranging from 20 to 259 cfs in 2013 and four to 57 cfs in 2007. Turbidity was higher at five of seven stations in 2007 compared to 2013. Nutrient data from both fall 2007 and 2013 were higher than recommended USEPA reference condition values. Nitrate + nitrite-N and total nitrogen were elevated at all of the stations, and these values were higher in 2013 than 2007. Total phosphorus was elevated at most of the sampling stations, and five of the seven stations had higher values in 2013 than 2007.

Table 18
Percent EPTT, Chironomidae, and Dominant Macroinvertebrate Taxa at the NFSR Test Stations, Spring 2007 and 2013 Glide/Pool Samples

Variable-Station	**NFSR #1**		**NFSR #2**	**NFSR #3**	**NFSR #5**		**NFSR #6**		**NFSR #7**		**NFSR #8**		**NFSR #8.5**	**NFSR #9**		**NRSR #9.5**	**NFSR #10**
Sample Year	2007	2013	2007	2007	2007	2013	2007	2013	2007	2013	2007	2013	2013	2007	2007	2013	2007
EPTT and Chironomidae Metrics																	
% EPTT	3.5	2.2	6.3	8.0	4.0	11.0	10.8	16.9	6.5	3.3	1.0	14.9	25.2	1.6	1.6	21.7	0.4
% Ephemeroptera	2.9	1.7	6.0	7.6	3.8	10.7	10.6	16.5	6.2	3.2	0.8	13.9	24.3	1.4	1.1	20.0	0.4
% Plecoptera			0.2				0.1		0.1					0.1	0.2		
% Trichoptera	0.7	0.4	0.2	0.4	0.2	0.3	0.1	0.4	0.2	0.1	0.1	0.1	0.9	0.1	0.2	1.7	
% Chironomidae	58.4	63.2	38.4	40.0	56.5	16.7	62.3	27.6	52.4	67.0	41.9	25.5	28.2	65.5	60.8	28.7	63.8
Percent Dominant Taxa																	
Cricotopus/Orthocladius	**11.6**	1.7	**9.1**	**30.7**	2.9	0.1	**30.3**	1.6	**19.9**	2.6	**9.7**	0.4	4.2	**25.4**	**22.0**	**4.7**	**25.7**
Glyptotendipes	**9.6**	0.4	0.4	0.3	**22.9**	2.7	0.4	3.4	1.0	**16.4**	0.2	0.5	1.8	1.6	0.6	0.7	2.1
Hydrobaenus	**7.8**	2.2	**16.9**	0.8	2.2		**9.9**	3.2	**9.0**	5.1	**22.7**	3.7	**4.9**	**21.9**	**26.4**	**6.5**	**27.7**
Procladius	**7.8**	0.4	0.8	**9.0**	**11.4**	0.7	**5.8**	0.6		0.9	0.6	0.3		0.1			0.5
Hyalella azteca	**7.4**	**4.4**	7.2	1.0	3.6	**14.8**	5.1	3.8	0.4	**7.8**		**23.8**	**14.1**			0.7	0.6
Tanytarsus	4.8	**26.9**	1.4	1.0	0.3	1.0	0.6	2.0	0.5	**8.1**	0.8	**5.5**	2.3	0.7	0.9	2.0	0.1
Tubificidae	5.0	**11.8**	**12.2**	**10.2**	**6.0**	**20.3**	2.1	**31.3**	**8.9**	3.1	**16.1**	**8.1**	**18.6**	**7.7**	**13.1**	**14.1**	**10.7**
Polypedilum illinoense	5.9	**6.8**		0.1	2.5	**6.9**	2.6	**7.9**	0.2	**8.4**		1.8	1.4			1.7	0.1
Dicrotendipes	5.1	**5.8**	1.6	1.3	**8.4**	3.9	4.1	0.2	5.8	**12.1**	1.3	3.3	**4.9**	**5.3**	1.5	1.2	1.5
Lirceus	0.2		**15.6**	**8.2**	4.3		4.4		3.7		**4.2**	0.8	0.3	0.8	1.6		0.3
Physella	0.2	0.6	**9.2**	2.8	1.2	3.4	1.4	1.0	**11.6**	0.2	**15.7**	3.5	0.5	5.1	**9.2**	**6.3**	0.8
Planariidae		0.6	0.3		**8.6**	0.7			0.3	0.1	0.1	0.3	0.3	1.4	0.3	0.2	
Caenis latipennis	2.5	1.5	5.9	**6.8**	3.8	**6.5**	**10.0**	**16.5**	6.2	3.1	0.8	**13.9**	**24.2**	1.3	1.2	**20.1**	0.4
Ceratopogoninae	2.1	1.6		2.2	3.3	1.5	**6.5**	1.2	1.4	0.7	2.9	4.6	0.4	2.1	2.1	0.4	**3.8**
Eukiefferiella			1.0	1.5	0.2		1.9	0.2	**10.4**	2.5	2.8	0.1	1.9	**8.4**	**6.8**	3.4	2.8
Hydrobiidae	2.1	1.7		0.1	0.3		**0.4**		0.5	2.0	**3.7**	**5.1**	0.8	0.7	0.5	1.0	0.2

Table 19
Physicochemical Variables at the NFSR Test Stations, 2006 and 2012 Fall Sampling Seasons

Variable-Station	**NFSR #1**		**NFSR #2**		**NFSR #3**		**NFSR #4**		**NFSR #4.5**	**NFSR #5**		**NFSR #6**		**NFSR #7**		**NFSR #8**		**NFSR #8.5**	**NFSR #9**	**NFSR #9.5**	**NFSR #10**
Sample Year	2006	2012	2006	2012	2006	2012	2006	2006	2012	2006	2012	2006	2012	2006	2012	2006	2012	2012	2006	2012	2006
Sample Date	9/28	9/26	9/27	9/25	9/27	9/28	9/27	9/27	9/27	10/4	9/27	10/4	10/10	10/3	9/25	10/3	9/25	9/26	10/03	10/10	10/03
Sample Time	1030	1520	1715	1515	1500	1100	1145	1150	1100	1700	0900	1010	1135	1650	1310	1445	1055	1100	1230	1000	0950
Ammonia	0.03[a]	0.10	0.03[a]	0.12	**2.91**	0.15	0.06	0.06	0.17	0.51	0.30	0.03[a]	0.08	0.03[a]	0.08	0.03[a]	0.11	0.14	0.03[a]	0.07	0.03[a]
Chloride	14.5	13.1	27.1	12.3	28	11.7	12.8	12.7	17.7	13.4	26.5	10.7	6.15	8.54	7.42	8.7	11.1	8.67	9.04	11.0	8.67
Sulfate		26.3		25.7		18.4			20.9		27.3		17.7		12.5		20.0	15.2		10.8	
TR Calcium		27.9		24.8		20.0			23.2		26.3		20.6		24.8		28.1	24.1		44.8	
TR Magnesium		3.53		3.70		3.28			3.67		4.50		3.01		2.89		3.26	2.81		3.64	
TR Hardness as $CaCO_3$		84.2		77.2		63.4			73.0		84.2		63.8		73.8		83.6	71.7		127	
Dissolved Oxygen	6.05	6.86	5.24	5.93	**4.43**	5.40	5.58	5.58	7.5	**3.78**	**3.94**	**4.34**	7.73	9.69	8.13	6.62	5.96	5.04	8.79	7.33	**4.31**
Discharge (cfs)	0.5	14.9	1.2	10.6	1.1	8.9	1.6	1.6	7.1	1.5	7.6	<0.1[c]	0.12	<0.1[c]	3.24	<0.1[c]	2.96	0.80	<0.1[c]	<0.1[d]	<0.1[c]
pH (Units)	7.8	7.2	7.7	6.8	7.8	7.5	7.8	7.8	7.5	7.8	7.5	7.6	8.1	8.7	7.6	7.8	7.3	7.4	7.8	7.7	7.5
Conductivity (µS/cm)	274	232	366	220	392	186	229	229	235	244	296	232	176	162	184	186	216	179	192	290	261
Temperature (°C)	14.5	20.0	19.0	21.0	18.0	20.0	17.5	17.5	20.0	19.0	20.0	21.0	12.0	22.0	20.0	23.5	18.0	19.0	22	12.0	19.5
Turbidity (NTU)	**5.8**	**17.0**	**10.3**	**19.7**	9.82	**15.7**	8.94	9.68	13.7	**20.9**	**16.9**	13.4	13.0	**49.4**	**16.6**	**42.4**	**16.7**	**25.6**	**39.4**	**2.57**	**15.7**
NFR		<5[a]		7.0		7.0			8.0		13.0		<5[a]		8.0		<5[a]	12.0	0.12	<5[a]	
Nitrate + Nitrite	0.01[b]	**1.02**	0.06	**0.83**	**0.65**	**0.68**	**0.29**	**0.29**	**0.79**	**0.51**	**0.88**	0.01[a]	0.06	**0.44**	**0.69**	**0.33**	**0.78**	**0.72**		0.05	0.01[a]
Total Nitrogen	**0.84**	**1.70**	**1.38**	**1.66**	**5.88**	**1.45**	**1.25**	**1.28**	**1.73**	**2.12**	**2.54**	**0.81**	**0.60**	**1.14**	**1.63**	**1.03**	**1.53**	**1.59**	**1.22**	**0.50**	**0.91**
Total Phosphorus	**0.08**	**0.06**	**0.07**	**0.11**	**0.12**	0.06	**0.15**	**0.14**	**0.14**	**0.34**	**0.32**	0.07	**0.09**	**0.17**	0.05	**0.24**	**0.10**	**0.19**	**0.2**	**0.06**	**0.11**

[a]Below detectable limits
[b]Estimated value, detected below Practical Quantitation Limit
[c]Discharge was not measured because stream had water only in isolated pools
[d]Discharge was not measured because water was barely flowing through riffles
Units mg/L unless otherwise noted. Values in bold are violations of the Missouri Water Quality Standards or elevated compared to EPA recommended reference condition values.

Table 20
Physicochemical Variables at the NFSR Test Stations, 2007 and 2013 Spring Sampling Seasons

Variable-Station	**NFSR #1**		**NFSR #2**	**NFSR #3**	**NFSR #5**		**NFSR #6**		**NFSR #7**		**NFSR #8**		**NFSR #8.5**	**NFSR #9**		**NFSR #9.5**	**NFSR #10**
Sample Year	2007	2013	2007	2007	2007	2013	2007	2013	2007	2013	2007	2013	2013	2007	2007	2013	2007
Sample Date	03/20	04/14	04/05	04/04	03/20	05/02	03/20	04/16	04/04	04/16	04/03	04/16	04/16	04/03	04/03	04/16	03/19
Sample Time	0950	0900	0915	1545	1230	1140	1445	1355	1210	1105	1615	1510	1245	1201	1207	1050	1545
Ammonia	0.08	0.25	0.03[a]	0.03[a]	0.14	0.23	0.03[a]	0.34	0.03[a]	0.22	0.03[a]	0.13	0.12	0.03[a]	0.03	0.12	0.03[a]
Chloride	25.4	13.6	18.7	19.6	28.2	11.7	23.4	12.7	20.9	14.2	21.2	14.9	15.8	21.8	21.8	15.1	25.4
Sulfate		39.2				27.3		43.5		28.7		26.8	25.3			20.6	
TR Calcium		38.2				33.4		34.4		41.5		44.6	45.2			57.3	
TR Magnesium		4.46				4.26		4.85		4.19		4.26	3.95			4.89	
TR Hardness as $CaCO_3$		114				101		106		121		129	129			163	
Dissolved Oxygen	6.89	8.76	8.29	8.25	7.32	7.17	7.63	8.96	8.4	9.13	8.29	9.98	8.85	6.52	6.52	9.20	8.49
Discharge (cfs)	47.5	258.9	57.1	43.0	15.2	N/A	9.4	86.7	20.4	39.5	22.4	40.6	27.5	20.0	20.0	20.0	3.9
pH (Units)	7.5	7.9	7.4	7.6	7.5	7.8	7.7	7.8	7.6	7.9	7.8	7.9	7.8	7.7	7.7	7.6	7.6
Conductivity (μS/cm)	334	282	364	349	334	245	314	259	388	273	345	286	292	343	343	282	302
Temperature (°C)	12.5	13.3	12.5	17.0	13.0	18.0	13.0	12.5	15.5	14.2	19.5	13.5	13.5	18.0	18.0	13.9	13.0
Turbidity (NTU)	**26.9**	**13.1**	15.2	**23.3**	**32.3**	13.3	8.74	**28.0**	**16.3**	12.3	9.89	6.71	**6.57**	**8.38**	**8.38**	**5.13**	**2.49**
NFR		15.0				17.0		46.0		18.0		11.0	7.00			5.00	
Nitrate + Nitrite	**1.32**	**1.90**	**1.74**	**1.2**	**0.73**	**1.16**	**1.01**	**1.60**	**1.80**	**2.41**[c]	**1.97**	**2.59**[c]	**2.64**[c]	**2.16**	**2.14**	**2.91**[c]	**1.7**
Total Nitrogen	**2.08**	**2.81**	**2.58**	**2.07**	**1.64**	**1.87**	**1.69**	**2.92**	**2.66**	**3.41**	**2.84**	**3.06**	**3.37**	**3.02**	**3.01**	**3.64**	**2.23**
Total Phosphorus	**0.1**	**0.13**	**0.11**	**0.15**	**0.13**	**0.16**	0.04[b]	**0.23**	**0.12**	**0.13**	**0.15**	0.08	**0.09**	**0.14**	**0.15**	**0.07**	0.02[b]

[a]Below detectable limits
[b]Estimated value, detected below Practical Quantitation Limit
[c]Sample diluted during analysis
Units mg/L unless otherwise noted. Values in bold are elevated compared to EPA recommended reference condition values.

5.0 Discussion

5.1 MSCI Scores and Biological Metrics

All of the NFSR test stations except the two most upstream stations had fully supporting MSCI scores during the fall 2012 sampling season (Tables 2 and 3). The MSCI score for NFSR #1 when compared to the RP Ozark/Osage EDU transitional criteria was 16. The values for BI and SDI at NFSR #1 were similar to but suboptimal compared to the Ozark/Osage EDU transitional criteria. Most of the test stations when compared to the Central Plains/Osage/South Grand EDU GP criteria had MSCI scores of 16. The only exceptions were NFSR #8.5-#9.5, which had MSCI scores of 14 and NFSR #1-#2, which had MSCI scores of 20. BI and SDI were suboptimal compared to the criteria for most of the sampling stations. BI using GP data ranged from slightly lower (BI =7.4) to slightly higher (7.7) than the criteria (BI = 7.6). All but the two most downstream stations (NFSR #1-#2) had BI values that were suboptimal compared to the GP criteria. Six of the ten stations using GP data had suboptimal values for SDI compared to the criteria (SDI = 2.85) with values ranging from much lower (SDI = 1.89) to slightly higher (SDI = 2.98). The values for SDI at test stations #4.5, #8.5, and #9.5 were especially low and likely resulted from high abundances of a few dominant taxa at these sampling stations (Table 7). *Hyalella azteca* and *Dicrotendipes* made up about 57 percent of the sample at test station #4.5; *Hyalella azteca* and *Caenis latipennis* made up about 72 percent of the sample at test station #8.5; and *Caenis latipennis* and *Glyptotendipes* made up about 50 percent of the sample at test station #9.5. The results for BI and SDI indicated that the macroinvertebrate community was made up of taxa that were tolerant and a few taxa made up a large percentage of the samples during the fall 2012 sampling season.

During the spring 2013 sampling season, all of the stations except NFSR #6 had MSCI scores of 14 or 16 using the Central Plains/Osage/South Grand EDU GP criteria (Table 4). The partially supporting NFSR #6 MSCI score (12) resulted from suboptimal values of TR, EPTT, and BI. High stream flows during the spring 2013 sampling season could have affected the MSCI scores at this station and NFSR #1. During laboratory processing, 50 percent of the SG and RM habitat for these sites was required to reach the target number, which suggests low macroinvertebrate abundance. Even after processing 50 percent of the samples, total macroinvertebrate counts were only 143 for the SG and 139 for RM at NFSR #1 and 71 for SG and 110 for RM at NFSR #6. By comparison, the target number for these habitats is 300 individuals each. The EPTT biological metric was low and BI was high compared to the criteria at all of the test stations during the spring 2013 sampling season. EPTT values were low at all stations, including stations that had fully supporting scores in 2013, but stations with partially supporting MSCI scores had lower EPTT values. The four stations that had partially supporting MSCI scores of 14 had three EPTT and the three stations that had fully supporting MSCI scores of 16 had four EPTT. With the exception of NFSR #6, this difference of one EPTT was the difference between an individual metric score of three or one and subsequently, a partially and fully supporting MSCI score. The results for EPTT and BI indicated that macroinvertebrate community during the spring 2013 sampling season was made up tolerant taxa, and very few EPTT were present. The results from both sampling seasons indicate the NFSR test stations had a borderline macroinvertebrate community compared to biological criteria.

5.2 Data Trend Differences for MSCI Scores and Biological Metrics

MSCI scores showed improvement at some of the NFSR test stations during the fall 2012 sampling season compared to the fall of 2006. With the exception of the two most upstream stations, all sites in 2012 had fully supporting MSCI scores. By comparsion, six of ten had fully supporting scores in 2006 (Table 14).

Two of the biological metrics used to calculate the MSCI (EPTT and BI) performed better at most of the stations in 2012. BI was lower at all of the stations and EPTT was higher at most of the stations in 2012 than 2006. Even with the improvements in the biological metrics and MSCI scores, most of the stations had borderline fully supporting MSCI scores, with six of nine GP stations having MSCI scores of 16 and the one RP station at NFSR #1 also having an MSCI score of 16.

The spring 2013 MSCI results were inconclusive compared to the spring 2007 results. Some stations had the same scores among years, others had higher scores, and some had lower scores (Table 15). Three stations had fully supporting MSCI scores of 16, three stations had partially supporting MSCI scores of 14, and one station had a partially supporting MSCI score of 12 during the spring 2013 sampling season. During the spring 2007 sampling season, four of ten samples had MSCI scores in the partially supporting range. Two of the biological metrics, EPTT and BI, were higher in more samples in 2007 than 2013. Four of seven samples in 2007 had higher values for EPTT and BI. Even though some values were higher in 2007, EPTT and BI were suboptimal compared to the criteria for all samples during both sampling years (2007 and 2013). EPTT values among test stations ranged from one to six in 2007 and from three to four in 2013. For BI, values ranged at the test stations from 7.3 to 8.3 in 2007 and from 7.7 to 8.4 in 2013. Results from biological metrics and MSCI scores from both sampling seasons indicate the NFSR stations were borderline compared to biological criteria, but they consistently had higher scores during the fall 2012 sampling season compared to 2006.

5.3 Macroinvertebrate Community Composition

The NFSR samples in 2012-2013 generally had lower BI values than samples collected in 2006-2007, but most of the most common taxa in 2012-2013 were still in the tolerant (BI 7.5-9.0) and very tolerant (BI > 9.0) range. During the fall 2012 sampling season, the only taxa with BI < 7.5 that were common in at least some samples were *Cricotopus/Orthocladius* group, *Tanytarsus*, and pisidiid clams (Table 7). During the spring 2013 sampling season, *Tanytarsus*, Acarina, *Ablabesmyia*, and *Helisoma* were the only common taxa with BI < 7.5 in NFSR samples (Table 9).

Percent EPTT was much higher at most sampling stations in 2012-2013 compared to 2006-2007, but most of the EPTT abundance was made up of the tolerant mayfly *Caenis latipennis* (BI=7.6). Other taxa that were common at multiple NFSR sampling stations during the fall 2012 sampling season were the chironomids *Tanytarsus* (BI = 6.7), *Dicrotendipes* (BI = 7.9), *Glyptotendipes* (BI = 8.5), the amphipod *Hyalella azteca* (BI = 7.9), and Tubificidae (BI = 9.2). During the spring 2013 sampling season, taxa that were common at multiple sampling stations in addition to *Caenis latipennis* were the chironomids *Hydrobaenus* (BI = 9.6), *Tanytarsus*, *Polypedilum illinoense* group (BI = 9.2), *Dicrotendipes*, the amphipod *Hyalella azteca*, and Tubificidae.

5.4 Land Use and Geology Effects on the Macroinvertebrate Community

Cropland makes up more than 50 percent and grassland makes up 35-42 percent of the land use at all of the NFSR test stations (Figure 1 and Table 1). Compared to the Ozark/Neosho EDU, the two Ozark/Osage transitional biological criteria streams and LDC, the NFSR had much more cropland and much less grassland. Forest cover was also much lower at NFSR test stations (three to 4.5 percent of land use) than reference conditions at Cedar, Horse, and LDCs (9.9 to 16.6 percent of land use) and the entire Ozark/Neosho EDU (20.3 percent of land use).

The NFSR and LDC are located within the South Deepwater AES type, which is characterized by sandstone and shale bedrock, low local relief of less than 100 feet, and soil surface textures of mainly silt loams of very slow to moderate infiltration rates. The local geology and soil types along with the lack of springs cause very low base stream flows during the summer and fall months even in the larger watersheds located within this AES type. The land use and geological conditions in the NFSR watershed are the most likely contributors to water quality problems leading to macroinvertebrate impairment at some of the sampling stations. Water quality problems that have been observed in the NFSR during this study or previous studies were low dissolved oxygen, sedimentation, turbidity, and nutrient enrichment.

5.4.1 Low Dissolved Oxygen

Dissolved oxygen data collection was not as extensive in this study as the 2006-2007 study, but there was some evidence that dissolved oxygen was probably low at some of the NFSR sampling stations during the low flow periods in the summer and fall months of 2012. During the fall 2012 macroinvertebrate sampling season, only NFSR #5 was below the water quality standard of 5 mg/L (Table 19). But the results from data collected by WQMS staff during the summer and fall months at four sampling stations indicated that dissolved oxygen could have been low for a long period of time at some of the sampling stations in 2012 (Table 12). The sampling station at SW 60th Road had low dissolved oxygen values during most of the summer and fall of 2012. Likewise, dissolved oxygen was also low for samples collected from May 31 to September 13, 2012, at the Highway 160 station. The SW 60th Road sampling station has instream habitat conditions that are very similar to NFSR #3 - #5, including a narrow U-shaped channel made up primarily of pool habitat and a high abundance of woody debris. At the Highway 160 station, discharge was very low (ranging from 0 to 0.2 cfs) when low dissolved oxygen levels were observed. More dissolved oxygen WQS violations occurred at bioassessment stations on macroinvertebrate sample collection dates in 2006 than 2012, but discharge values also were much lower at most sampling stations in 2006. During the fall 2006 sampling season, NFSR #3, #5, #6, and #10 all had dissolved oxygen concentrations below the Water Quality Standard.

Dissolved oxygen data loggers were set at four stations (NFSR #1, #3, #6, and #9) during the summer of 2006 (MDNR 2007). Dissolved oxygen levels were low for most of the readings at all four stations, with the fewest violations occurring at NFSR #1 (79.46 percent < 5 mg/L) with values ranging from 1.75 to 7.03 mg/L. The diurnal dissolved oxygen fluctuations were higher at NFSR #1 and higher values occurred in the afternoon hours than other stations where dataloggers were deployed. At NFSR #6, 99 percent of datalogger readings were below WQS, with values ranging from 2.80 to 5.19 mg/L. At NFSR #9, 98.4 percent of the datalogger readings were below WQS, with values ranging from 1.01 to 5.73 mg/L. The lowest dissolved oxygen readings occurred at NFSR #3 where all of the values were below WQS and ranged from 0.33 to 3.57 mg/L.

BI, a measure of macroinvertebrate tolerance to organic pollution, and is likely related to dissolved oxygen levels, was much lower at many of the NFSR stations during the fall 2012 sampling season compared to 2006 (Table 14). Many macroinvertebrate taxa that have high BI values are also tolerant of low dissolved oxygen levels. In 2012, BI ranged from 0.2 units lower at NFSR #3 to 1.0 units lower at NFSR #9.5 (compared to NFSR #10 in 2006) than 2006 values. In 2006, six of ten stations had BI values that were 0.5 units or more than 2012 values. Even though BI was improved at the NFSR sampling stations in 2012, most of the dominant taxa in samples had BI values in the tolerant or very tolerant range (BI> 7.5). The

tolerant amphipod *Hyalella azteca* was very abundant at all of the sampling stations, making up from about ten percent to 42 percent of the NFSR samples. The only EPTT that was common in samples was the tolerant mayfly *Caenis latipennis,* which was very abundant in test stations #5 - #9.5. Tubificid worms and the tolerant chironomids *Dicrotendipes* and *Glyptotendipes* were abundant at many of the sampling stations. *Dicrotendipes* specimens were not identified to species, but some species of *Dicrotendipes* have been found to be tolerant of nutrient enrichment and low dissolved oxygen levels. *Dicrotendipes neomodestus,* for example, is a species common to rivers and streams and has been found to be tolerant of nutrient enrichment and organic wastes (Epler 2001; Simpson and Bode 1980). Simpson and Bode (1980) found that *Dicrotendipes nervosus* is tolerant of high chlorides, high biochemical oxygen demand, and low dissolved oxygen levels. Another species, *Dicrotendipes simpsoni*, is tolerant of high nutrient levels and low dissolved oxygen (Epler 2001). *Glyptotendipes* commonly occurs in detritus-rich sediments of slow flowing rivers and becomes abundant in areas of organic pollution (Simpson and Bode 1980, Wiederholm 1983).

5.4.2 Sedimentation and Substrate Composition

Unlike previous studies (MDNR 2004, 2005a, 2008), stream habitat assessments and fine sediment volume analysis were not performed during this study. Based on visual observations made in the field, however, many of the sampling stations downstream of Lamar (NFSR #3 - #5) still had little or no hard bottom substrates such as gravel, cobble, and boulder. All of the sampling stations upstream of Lamar and NFSR #1 are transitional in nature with some gravel, cobble, and bedrock outcroppings present. Results from previous studies showed benthic sediment coverage was elevated at some NFSR stations.

Many of the low dissolved oxygen tolerant taxa that was common in the fall 2012 sampling season, such as Tubificidae, *Dicrotendipes*, and *Glyptotendipes*, are also tolerant of higher benthic sediment concentrations. *Glyptotendipes,* however, was not very abundant at the three sampling stations (NFSR #3 - #5) that had the highest amount of sediment deposition based on the habitat assessments in previous studies. Taxa that were common at these stations during the fall sampling season included *Hyalella azteca*, *Dicrotendipes,* and *Tanytarsus* at all three sampling stations, Tubificidae at NFSR #3 and #5, *Caenis latipennis* at NFSR #5, Acarina at NFSR #3, and the chironomids *Procladius* (BI = 9.3) and *Ablabesmyia* (BI = 6.4) at NFSR #4.5. Previous bioassessment studies by MDNR on the NFSR did not indicate that *Hyalella azteca*, *Tanytarsus,* or Acarina consistently preferred stream segments with elevated levels of benthic sediment (MDNR 2004, 2005a, 2008). *Hyalella azteca* was elevated in leaf pack samples collected during the fall 2004 sampling season at NFSR #4, but they were found in very low abundance at NFSR #3 and #5 (MDNR 2005a). *Hyalella azteca* was abundant at NFSR #3 - #5 during the fall 2006 sampling season, but they were also abundant at NFSR #1, #2, and #6 (MDNR 2008). During the spring 2007 sampling season, *Hyalella azteca* numbers were elevated at NFSR #3, but not much higher than any of the sampling stations downstream of Lamar. Although there is no evidence from previous studies that *Hyalella azteca* prefers streams with high benthic sediment levels, it was more abundant at NFSR #3 - #5 than the other stations. *Procladius* larvae are found in bottom sediments of bogs, ponds, lakes, and slower moving sections of streams (Epler 2001), which is indicative of a taxon that prefers higher benthic sediment levels.

The scraper FFG is known to be intolerant of elevated benthic sediment levels, and most of the stations known to have elevated levels of sediment had a lower percentage of scrapers than the reference conditions in fall 2012 (Figure 5 and Table 5). Rabeni et al. (2005) classified FFGs for sediment tolerance from

intolerant to tolerant in the following order: filterers < scrapers < predators < gatherer-collectors < shredders. The percentage of scrapers was low at most of the NFSR stations during fall 2012 compared to Central Plains/Osage/South Grand EDU reference conditions, but the lowest values occurred at NFSR #2 - #4.5. The two NFSR stations that had higher percent scraper values, NFSR #7 and #9.5, were located upstream of Lamar and had Ozark-like habitat conditions with well defined riffles and a larger percentage of the stream bottom made up of gravel and cobble substrates. The gatherer-collector FFG, which is known to be tolerant of sedimentation, was abundant at many of the sampling locations. The higher gatherer-collector values occurred at NFSR #3 - #6 and #8.5 and some of these stations have been documented as having elevated levels of sediment in previous studies.

During the spring 2013 sampling season, NFSR #5 was the only station with elevated benthic sediment levels based on previous studies. Many of the same taxa found in the fall 2012 sampling season, such as *Caenis latipennis* and *Hyalella azteca*, were abundant in the spring 2013 sample. Other taxa that were common in this sample were Tubificidae, *Polypedilum illinoense* group, and pisidiid clams. *Polypedilum illinoense* has been known to occur in a variety of conditions, including water bodies with high organic loading and low dissolved oxygen (Epler 2001). The same general trend that occurred during the fall 2012 sampling season for the scraper and gatherer-collector FFGs was observed in the spring 2013 samples. The percentage of scrapers was much lower than reference conditions for all of the sampling stations except NFSR #8 and #9.5. Gatherer-collector values were much higher than references among test stations, with the exception of NFSR #1 and #7.

Turbidity values of samples collected in 2006-2007 and 2012-2013 (Tables 19 and 20) were elevated at many of the NFSR stations compared to the USEPA recommended reference conditions for the Level III Central Irregular Plains or Ozark Highlands ecoregions. The elevated turbidity values likely indicate that a higher amount of sediment was present within the entire watershed since higher values occurred at multiple sampling locations despite benthic sediment deposits seeming to be more prevalent at stations immediately downstream of Lamar. The USEPA determined in the NFSR TMDL that the NFSR was impaired by sediment based on turbidity values (converted to Total Suspended Solids) reported in previous bioassessment studies (U.S EPA 2006).

5.4.3 Elevated Nutrient Levels

Nitrate + nitrite-N, total nitrogen, and total phosphorus were elevated at most of the NFSR sampling stations compared to USEPA recommended reference conditions for the Level III Central Irregular Plains or Ozark Highlands ecoregions during both sampling seasons (Tables 19 and 20). Nutrient values were generally higher during the two sampling seasons of this study compared to the results from the 2006-2007 study. Since there are few point sources in the watershed, most sampling stations are not likely affected by wastewater effluent. The Lamar WWTF probably has some effect on water quality at the two closest downstream stations (NFSR #4.5-#5). For the other sampling stations, runoff from agricultural practices are the likely primary sources of nutrient enrichment since most of the land use in the watershed consists of crop land and pasture land, and since the other two municipal point sources (Golden City and Jasper) have only minor WWTF discharges. Many of the same macroinvertebrate taxa common in samples that were described as being tolerant of low dissolved oxygen levels and elevated sediment levels are also considered tolerant of organic enrichment.

6.0 Conclusions

MSCI scores indicated impairment at two sampling stations during the fall 2012 sampling season and four stations in spring 2013. Samples were not collected at three stations during the spring 2013 season because stream flows were consistently high during the sampling period. The spring 2013 NFSR #1 and #6 partially supporting MSCI scores may have been affected by high stream flows since low macroinvertebrate numbers were found in SG and RM habitats at both sampling stations. A combination of elevated sediment levels, low dissolved oxygen levels, and elevated nutrient concentrations are likely contributors to the partially supporting and borderline fully supporting MSCI scores at most of the sampling stations since most of the common taxa in the NFSR are tolerant of these stressors.

Tests of the null hypotheses resulted in the following conclusions.

1) The macroinvertebrate community will not differ among longitudinally separate reaches of the NFSR. This hypothesis was rejected because the two most upstream NFSR stations during the fall 2012 sampling season and four of seven sampling stations in the spring 2013 sampling season had partially supporting MSCI scores.

2) The macroinvertebrate assemblages in the GP NFSR samples will be similar to the Central Plains Osage/South Grand EDU wadeable/perennial stream biological criteria. This hypothesis was rejected because the two most upstream NFSR stations during the fall 2012 sampling season and four of seven sampling stations in the spring 2013 sampling season had partially supporting MSCI scores.

3) The macroinvertebrate assemblage in the RP NFSR samples will be similar to criteria calculated from the two transitional RP wadeable/perennial streams from the Ozark/Osage EDU. This hypothesis was accepted because the RP sample during the fall 2012 sampling season had a fully supporting score of 16. A spring 2013 RP sample at this station was not collected because of high stream flows during the spring macroinvertebrate sampling period.

4) Physicochemical water quality in the NFSR will meet the WQS (**WQS**) of Missouri. The fourth null hypothesis was rejected because dissolved oxygen was below the water quality standard at NFSR #5 during the fall 2012 sampling season.

5) Physicochemical water quality will not differ among longitudinally separate reaches of the NFSR. The fifth hypothesis was accepted since similar trends occurred at all of the sampling stations. Except for the low dissolved oxygen value at NFSR #5 during the fall 2012 sampling season, most of the water quality parameters were similar, with elevated values for nutrients and turbidity.

7.0 Literature Cited

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Epler, J.H. 2001. Identification Manual for the Larval Chironomidae (Diptera) of North and South Carolina. http://esb.enr.state.nc.us/BAUwww/Chironomid.htm. North Carolina Department of Environment and Natural Resources.

Kentucky Division of Water (KDOW). 2009. Laboratory Procedures for Macroinvertebrate Processing, Taxonomic Identification and Reporting. Kentucky Department for Environmental Protection, Division of Water, Frankfort, Kentucky. 21 pp.

Merritt, R. W., K. W. Cummins, and M. B. Berg (eds). 2008. An introduction to the aquatic insects of North America (fourth edition). Kendall/Hunt Publishing Company, Dubuque, IA. 1158 pp.

Missouri Department of Natural Resources. 2002. Biological Criteria for Wadeable/Perennial Streams of Missouri. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 32 pp.

Missouri Department of Natural Resources. 2004. Upper North Fork of the Spring River Biological Assessment Study. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 34 pp.

Missouri Department of Natural Resources. 2005a. Lower North Fork of the Spring River Biological Assessment Study. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 32 pp.

Missouri Department of Natural Resources. 2005b. Lamar Wastewater Treatment Plant, North Fork of the Spring River Stream Survey Sampling Report. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 6 pp.

Missouri Department of Natural Resources. 2008. North Fork of the Spring River Biological Assessment and Stressor Study. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 70 pp.

Missouri Department of Natural Resources. 2010a. Taxonomic Levels for Macroinvertebrate Identification. MDNR-ESP-209. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 33 pp.

Missouri Department of Natural Resources. 2010b. Field Sheet and Chain-of-Custody Record. MDNR-ESP-002. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 14 pp.

Missouri Department of Natural Resources. 2011. Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations Standard Operating Procedure. MDNR-ESP-001. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 24 pp.

Missouri Department of Natural Resources. 2012. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 29 pp.

Missouri Department of Natural Resources. 2013. Flow Measurements in Open Channels Standard Operating Procedure. MDNR-ESP-113. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 13 pp.

Missouri Department of Natural Resources. 2014. Rules of the Department of Natural Resources Division-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031. Water Quality Standards. pp. 12-149.

Pflieger, W.L. 1989. Aquatic Community Classification System for Missouri. Missouri Department of Conservation Aquatic Series No. 19. 76 pp.

Rabeni, C.E., K.E. Doisy, L.D. Zweig. 2005. Stream Invertebrate Community Functional Responses to Deposited Sediment. Aquatic Sciences 67:395-402.

Simpson, K.W. and R.W. Bode. 1980. Common Larvae of Chironomidae (Diptera) from New York State Streams and Rivers with Particular Reference to the Fauna of Artificial Substrates. New York State Museum Bulletin 439:1-105.

Sowa, S.P., D.D. Diamond, R.A. Abbitt, G.M. Annis, T. Gordon, M.E. Morey, G.R. Sorensen, and D. True. 2004. Final Report of the Aquatic Component of GAP Analysis: A Missouri Prototype. Missouri Resource Assessment Partnership (MoRAP), University of Missouri. 111 pp.

Sowa, S.P. and D.D. Diamond. 2006. Using GIS and an Aquatic Ecological Classification System to Classify and Map Distinct Riverine Ecosystems Throughout EPA Region 7. Missouri Resource Assessment Partnership (MoRAP), University of Missouri. 242 pp.

United States Environmental Protection Agency. 2000a. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for River and Streams in Nutrient Ecoregion IX. United States Environmental Protection Agency, Office of Water, Washington, D.C., EPA-822-B-00-019. 32 pp.

United States Environmental Protection Agency. 2000b. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for River and Streams in Nutrient Ecoregion XI. United States Environmental Protection Agency, Office of Water, Washington, D.C., EPA-822-B-00-020. 28 pp.

United States Environmental Protection Agency. 2006. North Fork Spring River, Jasper County, Missouri, Total Maximum Daily Load. U.S. Environmental Protection Agency, Region 7, Water Wetlands, and Pesticides Division. 13 pp.

Wiederholm, T. (Editor). 1983. Chironomidae of the Holarctic Region. Keys and Diagnoses. Part I. Larvae. Entomol. Scand. Suppl. 19:1-457.

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Appendix A

North Fork of the Spring River Bioassessment Study Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120107], Station #1, Sample Date: 9/26/2012 4:00:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	CS	NF	RM	SG
"HYDRACARINA"				
Acarina	1	1	10	3
AMPHIPODA				
Hyalella azteca	36	33	124	32
ARHYNCHOBDELLIDA				
Erpobdellidae	3	1		
BASOMMATOPHORA				
Ancylidae	4		5	
Helisoma	-99			
Menetus	2		4	
Physella	5		2	2
Planorbella	1		3	
COLEOPTERA				
Berosus	41	14	5	4
Dineutus			-99	
Dubiraphia		2	8	
Ectopria nervosa	1	1		
Psephenus herricki	1			
Stenelmis	77		-99	
DIPTERA				
Ablabesmyia	2	26	7	2
Ceratopogoninae	2	1	2	2
Chironomidae	1			1
Chironomus				1
Cladopelma		10		1
Cladotanytarsus	5	1		2
Corynoneura	4			
Cricotopus bicinctus	5		1	3
Cricotopus/Orthocladius	13			15
Cryptochironomus	7	10		
Dicrotendipes	20	14	8	87
Dolichopodidae	1			
Eukiefferiella	14			
Forcipomyiinae				1
Glyptotendipes	2		5	12
Hemerodromia	1			
Microchironomus		1		
Nanocladius			4	
Nilothauma				2
Polypedilum convictum	33		3	3
Polypedilum halterale grp	14	2		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120107], Station #1, Sample Date: 9/26/2012 4:00:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	CS	NF	RM	SG
Polypedilum illinoense grp	32	3	5	14
Polypedilum scalaenum grp	28	6	1	2
Procladius		11		
Pseudochironomus	1			2
Rheotanytarsus	14			1
Simulium	24			
Stenochironomus	2			1
Stictochironomus		1		
Tanytarsus	115	71	60	46
Thienemanniella	3			
Thienemannimyia grp.	11			1
Tipula	1			
Tribelos	1			19
Xenochironomus				1
EPHEMEROPTERA				
Acerpenna	1		1	
Anthopotamus	-99	1		
Caenis latipennis	21	46	58	13
Leptophlebiidae	1			
Procloeon		4	1	2
Stenacron	3	1		
Stenonema femoratum	27	10		
Tricorythodes	194			1
HEMIPTERA				
Trichocorixa		2	1	
MEGALOPTERA				
Corydalus	1			
NEOTAENIOGLOSSA				
Hydrobiidae	1	1	2	2
ODONATA				
Argia	1	2	3	4
Basiaeschna janata			-99	
Enallagma			19	3
Epitheca (Epicordulia)			-99	1
Erythemis			2	
Gomphidae	1	2		
Gomphus		1		
Macromia	-99	1	-99	
Nasiaeschna pentacantha	-99			
Somatochlora		-99		
Tramea			1	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120107], Station #1, Sample Date: 9/26/2012 4:00:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	CS	NF	RM	SG
RHYNCHOBDELLIDA				
Glossiphoniidae			1	
TRICHOPTERA				
Cheumatopsyche	8			1
Hydroptila	6	4	1	3
Nectopsyche	3	3		
Oecetis		1		
Oxyethira	1			
TRICLADIDA				
Planariidae	5	1	1	3
TUBIFICIDA				
Branchiura sowerbyi	1	1		
Limnodrilus cervix		1		
Limnodrilus hoffmeisteri		1		
Quistradrilus multisetosus		4	1	
Tubificidae	60	14	1	
VENEROIDA				
Corbicula	4	2		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120104], Station #2, Sample Date: 9/25/2012 3:50:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	7	11	8
AMPHIPODA			
Hyalella azteca	3	193	44
ARHYNCHOBDELLIDA			
Erpobdellidae	7		
BASOMMATOPHORA			
Ancylidae	4	1	
Menetus	1	2	
Physella		1	1
COLEOPTERA			
Berosus	9	11	4
Scirtidae		1	2
Stenelmis	1		
DECAPODA			
Procambarus acutus		1	
DIPTERA			
Ablabesmyia	17	47	6
Ceratopogoninae	1	9	
Chaoborus	10		
Chironomus	1		
Cladopelma	18		
Cladotanytarsus	12	1	1
Cricotopus/Orthocladius	1	4	
Cryptochironomus	15		
Cryptotendipes	7		
Dasyheleinae		1	
Dicrotendipes	35	40	34
Forcipomyiinae			13
Glyptotendipes	15	7	66
Hydrobaenus		1	
Labrundinia		3	
Microchironomus	4		
Parachironomus		4	
Parakiefferiella		1	
Phaenopsectra		2	15
Polypedilum halterale grp	9	1	
Polypedilum illinoense grp	3	15	3
Polypedilum scalaenum grp	1	1	
Procladius	13	1	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120104], Station #2, Sample Date: 9/25/2012 3:50:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Pseudochironomus			2
Stempellinella		1	
Stictochironomus	1		1
Tabanidae		1	
Tanytarsus	28	111	12
Thienemannimyia grp.		1	1
Tribelos	2		4
EPHEMEROPTERA			
Acerpenna		2	
Caenis	7	6	
Callibaetis		5	
Procloeon	1	20	3
Stenacron	1	1	
HEMIPTERA			
Corixidae	1	4	
Rheumatobates		4	
Trichocorixa		1	
MEGALOPTERA			
Sialis	1		
ODONATA			
Argia	4	7	5
Basiaeschna janata		1	
Enallagma		6	
Epitheca (Epicordulia)	1	4	
Erythemis		2	
Gomphidae	1		
Macromia	1		
Perithemis	1		
RHYNCHOBDELLIDA			
Glossiphoniidae	4		
TRICHOPTERA			
Cyrnellus fraternus			3
Hydroptila		9	
TUBIFICIDA			
Limnodrilus hoffmeisteri	2		
Quistradrilus multisetosus	5	1	
Tubificidae	108	3	7
VENEROIDA			
Pisidiidae	16	1	1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120105], Station #3, Sample Date: 9/26/2012 9:20:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	55		7
AMPHIPODA			
Hyalella azteca	52	205	86
ARHYNCHOBDELLIDA			
Erpobdellidae	7	-99	
BASOMMATOPHORA			
Ancylidae	3		
Helisoma		1	
Menetus	4	1	3
Physella		3	1
COLEOPTERA			
Berosus	4	9	
DIPTERA			
Ablabesmyia	10	17	3
Ceratopogoninae	5	3	
Chaoborus	2		
Chironomus	1	1	
Cladopelma	4		
Cladotanytarsus	2		
Cryptochironomus	3		
Dicrotendipes	14	4	21
Forcipomyiinae			1
Glyptotendipes	3		4
Kiefferulus	3		
Ormosia	1		
Parachironomus		3	
Parakiefferiella			1
Polypedilum halterale grp	2		
Polypedilum illinoense grp	1	8	5
Polypedilum scalaenum grp	1		3
Procladius	26	2	2
Pseudochironomus	1		
Simulium	1		
Stenochironomus	1		
Stictochironomus	6		
Tanytarsus	27	14	8
Thienemannimyia grp.	1		1
Tribelos	1		13
Zavrelimyia		1	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120105], Station #3, Sample Date: 9/26/2012 9:20:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
EPHEMEROPTERA			
Baetidae		1	
Caenis latipennis	10	2	2
Callibaetis			1
Procloeon	1		1
Stenacron	3		7
HEMIPTERA			
Belostoma		-99	
Corixidae			2
Trepobates		1	
NEOTAENIOGLOSSA			
Hydrobiidae	1	4	2
ODONATA			
Argia	1	7	4
Epitheca (Epicordulia)	1	1	
Erythemis	1	1	
Ischnura		1	
Libellula		2	
Macromia	1	-99	1
Nasiaeschna pentacantha		1	
Pachydiplax longipennis		-99	
Perithemis	3		
Tramea		1	
RHYNCHOBDELLIDA			
Glossiphoniidae	4	1	
TRICHOPTERA			
Hydroptila	3	5	8
Oecetis	2		4
TUBIFICIDA			
Aulodrilus	18		
Branchiura sowerbyi	1		
Enchytraeidae	1		
Limnodrilus hoffmeisteri	3		
Quistradrilus multisetosus	6		
Tubificidae	62	9	
VENEROIDA			
Pisidiidae	6		3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120109], Station #4.5, Sample Date: 9/27/2012 11:20:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	9	7	1
AMPHIPODA			
Hyalella azteca	58	266	121
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae	4	4	1
Helisoma	1	3	-99
Physella	1	3	1
COLEOPTERA			
Berosus	3	2	2
DECAPODA			
Orconectes		1	
DIPTERA			
Ablabesmyia	17	12	13
Axarus	1		
Ceratopogoninae	3	20	4
Chaoborus	1		
Chironomidae	3		
Chironomus	1		2
Cladopelma	10		
Cladotanytarsus	8		2
Clinotanypus		1	
Cryptochironomus	2		
Cryptotendipes	1		2
Dicrotendipes	26	37	98
Glyptotendipes	1		
Kiefferulus	1		
Labrundinia			1
Microtendipes	1		
Nanocladius		2	1
Nilothauma	1		
Parachironomus	2	2	1
Parakiefferiella	3		
Paratanytarsus			3
Polypedilum halterale grp	6		
Polypedilum illinoense grp		9	
Procladius	43	2	6
Pseudosmittia	1		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120109], Station #4.5, Sample Date: 9/27/2012 11:20:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tanypus	2		
Tanytarsus	42	11	35
Thienemannimyia grp.	1		3
Tribelos	4	1	6
Zavreliella	1		
EPHEMEROPTERA			
Caenis latipennis	2	3	
Callibaetis		6	3
Centroptilum	2		2
Procloeon	2		
Stenacron	2		
HEMIPTERA			
Corixidae	1		
Neoplea		2	
Ranatra nigra		-99	
Rheumatobates	1	2	
Trepobates		2	
ODONATA			
Argia	1	6	2
Enallagma		2	
Epitheca (Epicordulia)	2	-99	
Libellulidae		1	
Macromia	-99	-99	
Nasiaeschna pentacantha		-99	
RHYNCHOBDELLIDA			
Glossiphoniidae	3		
TRICHOPTERA			
Ceraclea	2	1	
Hydroptila	2		8
Oecetis	1		1
TUBIFICIDA			
Aulodrilus	3		1
Branchiura sowerbyi	1		1
Quistradrilus multisetosus	7		
Tubificidae	27		1
VENEROIDA			
Pisidiidae	4	1	7

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120108], Station #5, Sample Date: 9/26/2012 1:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	4	8	6
AMPHIPODA			
Hyalella azteca	53	127	77
ARHYNCHOBDELLIDA			
Erpobdellidae	2	2	1
BASOMMATOPHORA			
Ancylidae	1	5	2
Helisoma		1	2
Menetus	1	1	2
Physella		5	7
Planorbella			1
COLEOPTERA			
Berosus	10	4	3
Peltodytes		3	
DIPTERA			
Ablabesmyia	10	3	5
Ceratopogoninae	2		3
Cladopelma	2		
Cladotanytarsus	2		1
Clinotanypus	1	1	
Cryptochironomus	1	1	
Cryptotendipes	6	1	
Dicrotendipes	9	2	40
Forcipomyiinae	1		10
Glyptotendipes			6
Goeldichironomus		2	
Nilothauma	1		
Parachironomus	2	1	
Parakiefferiella			1
Paralauterborniella	1		
Paratanytarsus		2	
Polypedilum illinoense grp	2	7	10
Polypedilum scalaenum grp	1	1	5
Procladius	13	2	
Pseudosmittia			2
Rheotanytarsus			2
Simulium			1
Stenochironomus			6
Tanytarsus	21	29	32

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120108], Station #5, Sample Date: 9/26/2012 1:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Thienemannimyia grp.			3
Tribelos	1		32
EPHEMEROPTERA			
Caenis latipennis	103	53	32
Callibaetis			1
Procloeon	2		1
Stenacron	8	2	7
HEMIPTERA			
Corixidae	1	1	
NEOTAENIOGLOSSA			
Hydrobiidae		2	1
ODONATA			
Argia	2	3	6
Enallagma	1	2	
Epitheca (Epicordulia)	1		1
Ischnura	1		
Libellula	3	1	1
Macromia	-99		
Somatochlora	2	1	1
RHYNCHOBDELLIDA			
Glossiphoniidae	6	2	1
TRICHOPTERA			
Hydroptila	1	3	1
Nectopsyche		1	
Oecetis	2	3	
Orthotrichia		1	
TRICLADIDA			
Planariidae	3	7	
TUBIFICIDA			
Aulodrilus		1	
Enchytraeidae			1
Limnodrilus hoffmeisteri	1		1
Quistradrilus multisetosus	4		
Tubificidae	41	9	7
VENEROIDA			
Pisidiidae	11	4	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120114], Station #6, Sample Date: 10/10/2012 11:45:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	10	2	
AMPHIPODA			
Hyalella azteca	6	73	31
ARHYNCHOBDELLIDA			
Erpobdellidae	1	2	
BASOMMATOPHORA			
Ancylidae	1	4	2
Helisoma	1	2	2
Menetus	1	10	4
Physella	1	9	3
COLEOPTERA			
Berosus	4	7	8
Dineutus		-99	
Dubiraphia		2	
Scirtidae		7	1
DIPTERA			
Ablabesmyia	8	5	7
Ceratopogoninae	2		
Chironomidae	1		3
Chironomus	48		5
Cladopelma	1		
Cladotanytarsus	14		1
Cricotopus bicinctus		1	1
Cricotopus/Orthocladius	2	2	
Cryptochironomus	16		
Dicrotendipes	7	10	71
Forcipomyiinae		1	2
Glyptotendipes		5	36
Hydrobaenus			1
Kiefferulus			1
Labrundinia		2	
Microtendipes	1		
Nanocladius	1		
Parachironomus		3	
Paratanytarsus		1	
Polypedilum halterale grp	6		
Polypedilum illinoense grp	5	9	4
Polypedilum scalaenum grp	2		
Procladius	5		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120114], Station #6, Sample Date: 10/10/2012 11:45:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Rheotanytarsus			1
Stenochironomus			3
Tanypus	1		
Tanytarsus	43	17	18
Thienemannimyia grp.		1	
Tribelos	1	1	32
EPHEMEROPTERA			
Baetidae		3	
Caenis latipennis	86	132	82
Leptophlebiidae		1	
Stenacron	1	3	8
Stenonema femoratum	1		1
HEMIPTERA			
Corixidae	1		
Rheumatobates		1	
LUMBRICINA			
Lumbricina		-99	
NEOTAENIOGLOSSA			
Hydrobiidae	3		4
ODONATA			
Argia		4	2
Basiaeschna janata		-99	
Enallagma		16	
Erythemis		5	
Libellula		-99	
Nasiaeschna pentacantha		-99	
RHYNCHOBDELLIDA			
Glossiphoniidae			1
TRICHOPTERA			
Hydroptilidae		1	
Oecetis	1		
TRICLADIDA			
Planariidae			1
TUBIFICIDA			
Branchiura sowerbyi	2		
Tubificidae	132	2	1
VENEROIDA			
Corbicula	20		1
Pisidiidae	4	-99	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120103], Station #7, Sample Date: 9/25/2012 1:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	4	20	12
AMPHIPODA			
Hyalella azteca	8	95	56
ARHYNCHOBDELLIDA			
Erpobdellidae	2		
BASOMMATOPHORA			
Ancylidae		2	1
Helisoma		6	3
Lymnaeidae			1
Menetus	5	2	3
Physella	2	14	10
Planorbella		1	1
COLEOPTERA			
Berosus	5		2
Peltodytes		1	
Scirtidae	1		1
Stenelmis	16	2	
DECAPODA			
Orconectes	-99		
DIPTERA			
Ablabesmyia	3		3
Ceratopogoninae	2	3	7
Chaoborus	1		
Chironomidae	6	6	1
Chironomus	1	1	1
Chrysops		1	
Cladopelma	1		
Cricotopus/Orthocladius			11
Cryptochironomus	3		2
Dicrotendipes	5	8	25
Diptera			1
Eukiefferiella			3
Forcipomyiinae	1		15
Glyptotendipes	19	18	23
Hydrobaenus			7
Kiefferulus		1	
Labrundinia	3	18	7
Nanocladius	1	3	2
Parachironomus		5	1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120103], Station #7, Sample Date: 9/25/2012 1:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Parakiefferiella			1
Paraphaenocladius			5
Paratanytarsus		1	1
Polypedilum halterale grp	4		
Polypedilum illinoense grp	1	11	29
Procladius	3		1
Pseudosmittia		1	1
Rheotanytarsus		1	1
Simuliidae			1
Tanytarsus	11	7	14
Thienemanniella			1
Tipulidae			1
Tribelos		2	1
Zavreliella	3		1
Zavrelimyia		2	1
EPHEMEROPTERA			
Caenis latipennis	114	94	35
Callibaetis			1
Procloeon			1
Stenonema femoratum	3		
HEMIPTERA			
Corixidae	1		
Neoplea		1	
Rheumatobates			1
NEOTAENIOGLOSSA			
Hydrobiidae	39	1	2
ODONATA			
Argia		9	2
Enallagma		11	1
Libellula		-99	
Nasiaeschna pentacantha			1
Perithemis	1	-99	
RHYNCHOBDELLIDA			
Glossiphoniidae	1		
TRICHOPTERA			
Oecetis	1	1	
TRICLADIDA			
Planariidae		2	1
TUBIFICIDA			
Branchiura sowerbyi	1		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120103], Station #7, Sample Date: 9/25/2012 1:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Quistradrilus multisetosus	15	2	1
Tubificidae	70	1	1
UNIONIDA			
Unionidae	-99		
VENEROIDA			
Pisidiidae	4		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120102], Station #8, Sample Date: 9/25/2012 11:45:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	4	28	28
AMPHIPODA			
Hyalella azteca	72	119	65
ARHYNCHOBDELLIDA			
Erpobdellidae	2		
BASOMMATOPHORA			
Ancylidae	1		2
Gyraulus		5	1
Helisoma	6	3	8
Lymnaeidae			2
Menetus	2		
Physella	2	15	4
COLEOPTERA			
Berosus	1		4
Stenelmis	5	1	
DIPTERA			
Ablabesmyia	5	4	3
Ceratopogoninae	6	6	4
Chaoborus	2		
Chironomidae	1	1	1
Chironomus	5		2
Cladopelma	5	4	2
Cladotanytarsus	1		
Cryptotendipes	9		
Dicrotendipes	11	4	21
Diptera			2
Dolichopodidae			2
Forcipomyiinae			12
Glyptotendipes	1	16	135
Kiefferulus		7	2
Labrundinia	3	13	4
Nanocladius		1	
Parachironomus		7	
Parakiefferiella	1	1	
Phaenopsectra	1		
Polypedilum illinoense grp		2	
Polypedilum scalaenum grp	1		
Procladius	6	3	4
Stenochironomus			1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120102], Station #8, Sample Date: 9/25/2012 11:45:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tanytarsus	22	5	9
Tribelos			2
Zavreliella	3		
EPHEMEROPTERA			
Caenis latipennis	37	53	10
Callibaetis	4		1
Heptageniidae	1		
Stenacron			1
HEMIPTERA			
Corixidae	10	3	1
Neoplea		1	
Rheumatobates		7	
NEOTAENIOGLOSSA			
Hydrobiidae	28		
ODONATA			
Argia		3	
Basiaeschna janata		-99	
Enallagma	3	11	1
Epitheca (Epicordulia)	1	-99	
Gomphidae		-99	
Libellula		1	
Macromia	1	-99	
Pachydiplax longipennis		-99	
Somatochlora	1	-99	
RHYNCHOBDELLIDA			
Glossiphoniidae		-99	
TRICHOPTERA			
Hydroptila		1	
TUBIFICIDA			
Branchiura sowerbyi	27	2	
Limnodrilus hoffmeisteri		1	
Tubificidae	10	7	
UNIONIDA			
Unionidae	1		
VENEROIDA			
Pisidiidae	19	-99	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120106], Station #8.5, Sample Date: 9/26/2012 11:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina		6	23
AMPHIPODA			
Hyalella azteca	38	84	71
ARHYNCHOBDELLIDA			
Erpobdellidae	1		-99
BASOMMATOPHORA			
Ancylidae	2	4	3
Gyraulus	2	4	8
Helisoma	2	1	6
Menetus		1	
Physella			1
Planorbella		1	1
COLEOPTERA			
Berosus	2	2	4
Scirtidae			1
Stenelmis	1		
DIPTERA			
Ablabesmyia	3	2	1
Ceratopogoninae	1	1	8
Chironomidae		1	
Chironomus			3
Cladopelma	1		
Cryptotendipes	1		
Dicrotendipes	1	1	34
Forcipomyiinae	1		10
Glyptotendipes	2	4	31
Labrundinia		5	
Microchironomus	1		
Nanocladius		2	
Parachironomus		5	
Paratanytarsus			1
Polypedilum fallax grp			2
Polypedilum halterale grp	1		
Polypedilum tritum			2
Procladius	3		1
Pseudosmittia		1	1
Tanytarsus	4	5	6
Tribelos			5
EPHEMEROPTERA			

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120106], Station #8.5, Sample Date: 9/26/2012 11:30:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Caenis latipennis	271	200	116
Callibaetis		1	
Procloeon	1		
Stenonema femoratum	4		
LUMBRICINA			
Lumbricina	-99		
NEOTAENIOGLOSSA			
Hydrobiidae	12	1	5
ODONATA			
Argia			1
Enallagma	1	17	2
Epitheca (Epicordulia)	1	-99	
Erythemis		2	
Libellula	2	-99	
Macromia	-99		
Perithemis	-99		
Tramea		-99	
TRICHOPTERA			
Hydroptila	1	3	3
Oecetis	1		
Orthotrichia		1	
TRICLADIDA			
Planariidae		2	1
TUBIFICIDA			
Branchiura sowerbyi	1		
Tubificidae	1		2
UNIONIDA			
Unionidae	-99		
VENEROIDA			
Pisidiidae	2	4	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120113], Station #9.5, Sample Date: 10/10/2012 10:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	34	26	3
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	
BASOMMATOPHORA			
Ancylidae	7	3	1
Gyraulus	7	1	6
Helisoma	12	13	11
Menetus		6	
Physella	9	15	2
Planorbella	-99		
COLEOPTERA			
Berosus	3	2	1
Dytiscidae		1	
Enochrus			1
Scirtidae		5	11
Stenelmis	7		
DECAPODA			
Orconectes virilis	-99		
DIPTERA			
Ablabesmyia			2
Ceratopogoninae	1		
Chironomidae	1	2	2
Chironomus	2		
Cladopelma	1		
Cricotopus/Orthocladius		1	1
Cryptochironomus	1		
Dicrotendipes	2	2	74
Glyptotendipes	8	5	98
Hydrobaenus	1		
Microtendipes	5	1	1
Nanocladius		2	
Parachironomus			1
Parakiefferiella			1
Paraphaenocladius			1
Paratendipes	3		
Phaenopsectra		1	1
Polypedilum fallax grp			6
Polypedilum halterale grp	2		
Polypedilum illinoense grp	4	2	19

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [120113], Station #9.5, Sample Date: 10/10/2012 10:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Polypedilum scalaenum grp	3		
Procladius	2		
Stenochironomus			1
Tanytarsus	11		
Tribelos	2	1	24
Zavreliella	1		
EPHEMEROPTERA			
Caenis latipennis	195	153	31
Stenacron	6	1	14
Stenonema femoratum	4		6
HEMIPTERA			
Ranatra nigra		1	
LUMBRICINA			
Lumbricina	-99		
NEOTAENIOGLOSSA			
Hydrobiidae	22		
ODONATA			
Argia	-99		
Dromogomphus		1	
Enallagma		33	
Epitheca (Epicordulia)		-99	
Erythemis		3	1
Libellula	-99	-99	
Nasiaeschna pentacantha		1	
Pachydiplax longipennis		-99	
Somatochlora		1	
RHYNCHOBDELLIDA			
Glossiphoniidae	1		
TRICLADIDA			
Planariidae		1	
TUBIFICIDA			
Branchiura sowerbyi	2		
Tubificidae	3	4	
VENEROIDA			
Pisidiidae	8	3	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131916], Station #1, Sample Date: 4/17/2013 9:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1		2
AMPHIPODA			
Hyalella azteca	6	20	4
ARHYNCHOBDELLIDA			
Erpobdellidae	2		
BASOMMATOPHORA			
Gyraulus			1
Lymnaeidae		5	6
Physella	1	3	
Planorbella	1		
BRANCHIOBDELLIDA			
Branchiobdellida		1	
COLEOPTERA			
Dubiraphia	1		1
Stenelmis	1		
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Ablabesmyia	3	7	2
Ceratopogoninae	11		
Chironomus	1		
Chrysops	1		
Cladotanytarsus	7		
Cricotopus bicinctus	1	1	
Cricotopus/Orthocladius	5	3	4
Cryptochironomus	13		
Cryptotendipes	1	1	
Dasyheleinae			2
Dicrotendipes	10	5	25
Diptera	1		
Forcipomyiinae			2
Glyptotendipes			3
Hydrobaenus	3	2	10
Mesosmittia		2	
Micropsectra	1	3	
Nanocladius			2
Nilothauma	2		
Parachironomus	1		
Parakiefferiella	1	2	1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131916], Station #1, Sample Date: 4/17/2013 9:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Paralauterborniella	8		
Polypedilum convictum	1		
Polypedilum halterale grp	18		1
Polypedilum illinoense grp	1	25	22
Polypedilum scalaenum grp	25	1	
Procladius	3		
Pseudochironomus			2
Pseudosmittia			2
Simulium	2	3	2
Stempellinella	1		
Stictochironomus		1	
Tanytarsus	149	18	18
Thienemannimyia grp.	2		9
Tribelos			3
Xenochironomus	3		
EPHEMEROPTERA			
Caenis latipennis	6	3	1
Stenacron		1	1
HEMIPTERA			
Trichocorixa	1		2
NEOTAENIOGLOSSA			
Hydrobiidae	6	2	4
ODONATA			
Argia			1
Basiaeschna janata		-99	
Dromogomphus	-99		
Enallagma		5	
Epitheca (Tetragoneuria)	-99		
Ischnura		1	
Macromia	1		
Nasiaeschna pentacantha		-99	
TRICHOPTERA			
Hydroptila		2	1
TRICLADIDA			
Planariidae	3		1
TUBIFICIDA			
Enchytraeidae	4	17	3
Limnodrilus claparedianus	1		1
Limnodrilus hoffmeisteri	4	1	
Quistradrilus multisetosus	4		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131916], Station #1, Sample Date: 4/17/2013 9:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tubificidae	74	4	3
VENEROIDA			
Pisidiidae	15		1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131914], Station #5, Sample Date: 5/2/2013 12:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca	19	10	
ARHYNCHOBDELLIDA			
Erpobdellidae	6	13	-99
BASOMMATOPHORA			
Ancylidae		4	3
Helisoma	1		-99
Lymnaeidae			1
Physella	1	17	7
DECAPODA			
Orconectes		1	
DIPTERA			
Ablabesmyia		1	
Ceratopogoninae	4	7	
Chironomus		1	1
Cladotanytarsus	1		
Cricotopus bicinctus		1	4
Cricotopus sylvestris grp			1
Cricotopus/Orthocladius	1		
Cryptochironomus	1		
Cryptotendipes	1		
Dicrotendipes	33	12	6
Diplocladius	1		
Diptera	9		
Glyptotendipes	1	1	7
Gonomyia			1
Micropsectra		2	
Parakiefferiella	1	3	2
Polypedilum halterale grp	5	1	2
Polypedilum illinoense grp		3	4
Polypedilum scalaenum grp	2		1
Procladius	4		1
Stenochironomus	1		1
Thienemannimyia grp.		1	1
Tribelos	6	5	3
EPHEMEROPTERA			
Caenis latipennis	7	58	11
Stenacron		1	2
HEMIPTERA			
Corixidae		1	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131914], Station #5, Sample Date: 5/2/2013 12:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
LUMBRICINA			
Lumbricina	1		
NEOTAENIOGLOSSA			
Hydrobiidae	2	12	6
ODONATA			
Argia	2	2	4
Enallagma		1	
Epitheca (Epicordulia)	1	5	
Gomphus	-99	2	
Libellula		18	1
Macromia	-99	1	1
Nasiaeschna pentacantha		2	
Somatochlora	1		
RHYNCHOBDELLIDA			
Glossiphoniidae	3	12	6
TRICHOPTERA			
Cheumatopsyche		1	
Hydroptila		1	
TRICLADIDA			
Planariidae		4	1
TUBIFICIDA			
Aulodrilus			4
Branchiura sowerbyi		1	
Enchytraeidae	2	4	13
Ilyodrilus templetoni	4	2	
Limnodrilus claparedianus	4		
Limnodrilus hoffmeisteri	21	24	3
Tubificidae	98	29	23
VENEROIDA			
Pisidiidae	14	73	22

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131917], Station #6, Sample Date: 4/16/2013 2:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca	4	3	12
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
BASOMMATOPHORA			
Menetus	1		
Physella	1	1	3
COLEOPTERA			
Tropisternus		1	
DIPTERA			
Ablabesmyia	2		
Ceratopogoninae	6		
Cricotopus/Orthocladius	2	4	2
Cryptochironomus	3		
Cryptotendipes	1		
Dicrotendipes	1		
Diplocladius			1
Diptera	2		
Eukiefferiella			1
Glyptotendipes	9	2	6
Hydrobaenus	8	5	3
Mesosmittia		1	
Polypedilum fallax grp			1
Polypedilum halterale grp	6		2
Polypedilum illinoense grp	10	24	5
Polypedilum scalaenum grp	18	2	1
Procladius	3		
Simulium		15	2
Stenochironomus	1		
Stictochironomus	3		
Tanytarsus	8		2
EPHEMEROPTERA			
Caenis latipennis	32	36	14
HEMIPTERA			
Trichocorixa			1
ODONATA			
Nasiaeschna pentacantha	-99	1	
TRICHOPTERA			
Hydroptilidae		1	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131917], Station #6, Sample Date: 4/16/2013 2:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Oxyethira		1	
TUBIFICIDA			
Branchiura sowerbyi	1		
Enchytraeidae	8	6	7
Limnodrilus claparedianus	5		
Limnodrilus hoffmeisteri	24	1	3
Spirosperma	2		
Tubificidae	144	6	5
VENEROIDA			
Pisidiidae	9		

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131918], Station #7, Sample Date: 4/16/2013 11:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Hyalella azteca	9	50	6
ARHYNCHOBDELLIDA			
Erpobdellidae	2		
BASOMMATOPHORA			
Gyraulus		2	2
Helisoma	1	3	1
Menetus		3	4
Physella		1	1
COLEOPTERA			
Ancyronyx variegatus			1
Peltodytes		2	
Stenelmis	8		1
DECAPODA			
Procambarus acutus			1
DIPTERA			
Ablabesmyia	12	8	3
Ceratopogoninae	4	1	1
Cladopelma	5		
Cladotanytarsus	1		
Clinotanypus			1
Cricotopus/Orthocladius		4	18
Cryptochironomus	1		
Cryptotendipes	2		
Dasyheleinae			2
Dicrotendipes	16	51	34
Diplocladius		1	7
Diptera	6		2
Eukiefferiella	1	2	18
Glyptotendipes	10	52	75
Hydrobaenus	6	9	28
Microchironomus	1		
Nanocladius		2	
Parachironomus		9	
Parakiefferiella	1	4	
Paratendipes	11		1
Polypedilum	1		
Polypedilum convictum	1		1
Polypedilum halterale grp	10		
Polypedilum illinoense grp		25	45

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131918], Station #7, Sample Date: 4/16/2013 11:00:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Polypedilum scalaenum grp	3		
Procladius	7		1
Pseudochironomus			1
Simulium		4	11
Stictochironomus			3
Tanytarsus	36	27	5
Thienemanniella		1	
Tipula		-99	
EPHEMEROPTERA			
Caenis latipennis	5	13	8
Stenacron			1
LUMBRICINA			
Lumbricina	1		
NEOTAENIOGLOSSA			
Hydrobiidae	2	11	4
ODONATA			
Argia	1		1
Dromogomphus		-99	
Enallagma		8	
Epitheca (Epicordulia)		-99	
Nasiaeschna pentacantha		-99	
RHYNCHOBDELLIDA			
Glossiphoniidae	1	1	
TRICHOPTERA			
Oecetis		1	
TRICLADIDA			
Planariidae		1	
TUBIFICIDA			
Branchiura sowerbyi	4		
Enchytraeidae	6	5	3
Limnodrilus claparedianus	2		
Limnodrilus hoffmeisteri	6	2	
Limnodrilus udekemianus		1	
Quistradrilus multisetosus	23	1	1
Tubificidae	15	10	1
VENEROIDA			
Pisidiidae	4	1	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131919], Station #8, Sample Date: 4/16/2013 3:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	13	2	6
AMPHIPODA			
Hyalella azteca	11	196	30
ARHYNCHOBDELLIDA			
Erpobdellidae	2	-99	1
BASOMMATOPHORA			
Ancylidae	3		
Gyraulus	1	4	7
Helisoma		6	2
Lymnaeidae			1
Menetus	1	6	2
Physella		1	34
BRANCHIOBDELLIDA			
Branchiobdellida			1
COLEOPTERA			
Berosus	2		
Stenelmis	2		
DIPTERA			
Ablabesmyia	6	3	5
Ceratopogoninae	22	1	23
Cladopelma	7		2
Cricotopus bicinctus			1
Cricotopus/Orthocladius		2	2
Cryptochironomus			1
Cryptotendipes	2		
Dicrotendipes	6	14	13
Diplocladius	1	1	4
Eukiefferiella			1
Glyptotendipes	1	2	2
Hydrobaenus	11	4	22
Microchironomus	2		
Micropsectra		1	1
Parakiefferiella	2		3
Paratendipes	11	1	1
Phaenopsectra			1
Polypedilum halterale grp	5		3
Polypedilum illinoense grp		6	12
Polypedilum scalaenum grp	11		3
Procladius	2	1	

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131919], Station #8, Sample Date: 4/16/2013 3:30:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Pseudosmittia			17
Simulium			3
Tanytarsus	30	8	17
Tribelos	2		1
Zavreliella	1		
EPHEMEROPTERA			
Caenis latipennis	55	52	32
HEMIPTERA			
Ranatra nigra		1	
Trichocorixa		1	
ISOPODA			
Lirceus	2	5	1
LUMBRICULIDA			
Lumbriculidae	2		
NEOTAENIOGLOSSA			
Hydrobiidae	19	12	20
ODONATA			
Argia		2	
Enallagma	2	7	
Epitheca (Epicordulia)	1	-99	-99
Libellula			2
RHYNCHOBDELLIDA			
Glossiphoniidae			-99
TRICHOPTERA			
Ceraclea		3	
Hydroptila	1	1	4
Oecetis	1		
TRICLADIDA			
Planariidae		3	
TUBIFICIDA			
Enchytraeidae	9	3	8
Limnodrilus hoffmeisteri	7	1	1
Tubificidae	68	5	8
UNIONIDA			
Unionidae	-99		
VENEROIDA			
Pisidiidae	19	1	2

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131920], Station #8.5, Sample Date: 4/16/2013 1:15:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	4		3
AMPHIPODA			
Hyalella azteca	19	100	20
Stygobromus	1		
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	
BASOMMATOPHORA			
Ancylidae	1		
Gyraulus	7	5	21
Helisoma		3	1
Lymnaeidae			2
Menetus		2	1
Physella	1	1	3
COLEOPTERA			
Ancyronyx variegatus		1	
Berosus	3		
Stenelmis	2		
DIPTERA			
Ablabesmyia	4		
Ceratopogoninae	2		2
Chironomidae	4		
Chironomus	1		
Cladopelma	1		
Cricotopus/Orthocladius	4	15	22
Cryptotendipes	2		
Dicrotendipes	3	3	42
Diplocladius		6	3
Diptera	1		
Eukiefferiella		10	9
Forcipomyiinae			2
Glyptotendipes	2	1	15
Hydrobaenus	1	15	32
Mesosmittia			1
Micropsectra		4	2
Nilothauma			2
Parakiefferiella		4	1
Paratendipes	6		1
Polypedilum halterale grp			11
Polypedilum illinoense grp	2	2	10

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131920], Station #8.5, Sample Date: 4/16/2013 1:15:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Polypedilum scalaenum grp	4		3
Pseudosmittia			2
Simulium		7	2
Stenochironomus			1
Stictochironomus			1
Tanytarsus		8	15
Thienemanniella		1	
Tribelos			2
EPHEMEROPTERA			
Caenis latipennis	50	126	63
Stenonema femoratum		1	
ISOPODA			
Lirceus		1	2
NEOTAENIOGLOSSA			
Hydrobiidae	1	2	5
ODONATA			
Argia		-99	
Enallagma	2	18	2
Epitheca (Epicordulia)	-99	-99	
Libellula		1	
RHYNCHOBDELLIDA			
Glossiphoniidae	1		
TRICHOPTERA			
Ceraclea	1	2	
Hydroptila		1	5
TRICLADIDA			
Planariidae	1	1	1
TUBIFICIDA			
Branchiura sowerbyi	4		
Enchytraeidae			7
Tubificidae	178	2	4
VENEROIDA			
Pisidiidae		6	3

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131921], Station #9.5, Sample Date: 4/16/2013 11:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	13		5
AMPHIPODA			
Hyalella azteca		2	4
ARHYNCHOBDELLIDA			
Erpobdellidae	1	5	
BASOMMATOPHORA			
Ancylidae	1		
Gyraulus	14	55	14
Helisoma		2	1
Lymnaeidae	3	1	2
Menetus	1	3	
Physella	12	28	17
Planorbella		-99	
COLEOPTERA			
Berosus	4		
Dineutus		-99	
Peltodytes		1	
Stenelmis	2		
DIPTERA			
Ablabesmyia	4	6	1
Ceratopogoninae	1		3
Cladopelma	2		
Cricotopus sylvestris grp		1	
Cricotopus/Orthocladius	2	2	38
Cryptochironomus	1		
Dicrotendipes	1	3	7
Diplocladius			2
Diptera	9		
Endochironomus			1
Eukiefferiella	1	1	29
Glyptotendipes		1	5
Hydrobaenus	22	8	29
Larsia	1		
Micropsectra		13	3
Nanocladius		1	
Parachironomus		2	
Parakiefferiella		1	
Paraphaenocladius			1
Paratendipes	18		1

Aquid Invertebrate Database Bench Sheet Report
North Fk Spring R [131921], Station #9.5, Sample Date: 4/16/2013 11:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Polypedilum convictum			1
Polypedilum halterale grp	9		1
Polypedilum illinoense grp	1	5	9
Polypedilum scalaenum grp	6		1
Simulium			5
Tanytarsus	8	7	3
EPHEMEROPTERA			
Caenis latipennis	40	119	22
LUMBRICULIDA			
Lumbriculidae	1		
NEOTAENIOGLOSSA			
Hydrobiidae	1	7	1
ODONATA			
Argia		1	
Basiaeschna janata		-99	
Enallagma	-99	19	
Epitheca (Epicordulia)	1	1	
Erythemis	-99	6	
Libellula	-99	-99	
Somatochlora	-99	1	
RHYNCHOBDELLIDA			
Glossiphoniidae			1
Piscicolidae	1	-99	
TRICHOPTERA			
Hydroptila	1		
Oecetis	1	13	
TRICLADIDA			
Planariidae		2	
TUBIFICIDA			
Enchytraeidae	6	4	8
Limnodrilus hoffmeisteri	19		
Tubificidae	123	3	1
VENEROIDA			
Pisidiidae	25	3	3